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THE GROWTH OF WORD MEANING DURING MIDDLE CHILDHOOD

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THE GROWTH OF WORD MEANING DURING MIDDLE CHILDHOOD

by

JANICE MARIE HAMBLEY

Department of Educational Theory

A Thesis submitted in conformity with the requirements
for the Degree of Doctor of Philosophy in the
University of Toronto

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ABSTRACT

This thesis reports an investigation of children's understanding of word meaning, with particular interest focused on the encoding of semantic features. Previous research has shown that adults derive complex word meaning from the encoding of multiple features. This study was designed to investigate whether children, like adults, encode several semantic features at a time, thereby exhibiting a similar potential for rich comprehension of word meaning.

Following Bruner, Olver and Greenfield (1967), Clark (1973), Anglin (1970) and others, one possible prediction would hold that developmental differences would be found in the encoding patterns of younger and older children, with younger children encoding fewer features than older children. However, the alternative viewpoints of Huttenlocher (1974) and Rosch (1973, 1975) would predict that younger and older children would exhibit comparable encoding patterns if certain relevant variables were controlled in the study. Rosch (1973, 1975) found that children and adults exhibited similar patterns in their comprehension of word meaning when the words were central members of a category. Differences between children and adults appeared when peripheral members of a category were presented. Huttenlocher found, when studying comprehension of meaning and not verbal production, that children and adults were comparable in abilities. In the present study only words which were rated as being central members of the categories under investigation were used as stimulus items. Also, the procedure employed in the research measured

comprehension of word meaning without requiring overt production of categorizing responses.

The method used to study these different theoretical positions was Wicken's Release from Proactive Inhibition technique. This is an immediate memory procedure which allows one to manipulate the degree of apparent overlap in meaning of categories of words and to measure the subjects' recall of the differences in meaning overlap.

The subjects were 256 children in grades 3 and 6. The children in both grades were divided into two groups according to vocabulary test scores to form a high and low verbal ability group per grade. Children were assessed for their ability to differentiate between four categories of words varying in feature overlap. Differences in recall scores, reflecting differences in the children's perception of feature overlap (Wickens, Dalezman & Eggemeier, 1976), were measured as a function of experimental condition, age and level of verbal ability.

The results indicated that children from both grades and both levels of verbal ability comprehended the meanings of the words in a manner similar to adults. The recall of the high and low verbal ability children in grades 3 and 6 was consistent with an interpretation of multiple encoding of semantic features. Differences between the two grades and the two levels of verbal ability occurred only with respect to overall recall; the relative recall of one category to another was consistent across all groups of subjects. These data supported the findings of Rosch (1973, 1974) and Huttenlocher (1974) with regard to children's understanding of word meaning. Like adults, children demonstrated an ability to encode multiple features of meaning.

This apparent consistency in multiple encoding of semantic features across two age groups of children and adult subjects, led to the conclusion that quite possibly the underlying structure of semantic encoding might be common to language users of all ages. While the feature lists associated with word meanings are frequently different for children and adults, when multiple features are attached to word meaning, it is suggested that both children and adults are capable of multiple encoding.

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CHAPTER I

INTRODUCTION

This study is concerned with one aspect of the relationship between language and thought, specifically how children's short-term recall of word items reflects the way in which words are organized and interrelated in memory. Words belonging to four noun categories were presented and by analyzing recall responses, the children's awareness of the category memberships as well as their perception of the interrelatedness of the categories was assessed. The intent of the research is to examine and help clarify children's understanding of word meaning through an analysis of their recall of the semantic overlap of the four categories of words. As well as reaching some conclusions about how word meaning is encoded in memory, some understanding of the formation of children's categories will be achieved.

The study of thought as reflected through an analysis of language and behaviour has a long history. Of the early researchers concerned with the relationship between language and thought, two remain dominant today. Both Jean Piaget (Sinclair-De-Swart, 1969) and Lev Vygotsky (1962) studied the development of speech and thinking in children and noted changes occurring in both of these capacities throughout the childhood years and into early adolescence. Both theorists saw language as a tool of thought, helping in organization, classification and hierarchization of relationships. Language was described as a system of signs and to be a system required that the elements be organized.

Vygotsky's (1962) analysis of the language - thought relationship has particular relevance to the research to be described in this thesis. Vygotsky felt that the key to tapping verbal thought, the term applied to the overlap between language and thought, was through an analysis of word meaning. Meaning was seen as an act of thought as well as a part of the word and therefore belonged both to language and to thought. Vygotsky proposed that a word referred to a group or class of objects, not a single object, and therefore each word was a generalization. Word meaning was defined by characteristic features. Vygotsky considered word meanings to evolve during childhood, changing as the child developed. Adults and children frequently differed in their meanings for the same words, but would still be able to understand one another because the course of the development of word meaning was predetermined by the adult's language.

The research of this thesis is directed towards an analysis of word meaning with a view to interpreting how children represent meaning in memory. Word meaning is defined in terms of features, the hypothetical construct proposed by Vygotsky and since supported by many researchers. Inferences about the encoding and organization of features in memory are made.

In the last decade or so, considerable research into children's semantic development has been conducted. Emphasis has often been on determining how children's knowledge of word meaning changes over the childhood and adolescent years with adult competence viewed as the end goal. The present research also addresses this problem but the perspective taken differs from previous endeavours.

In the study of feature representation in children, there has been a tendency to focus on the relative salience of different types of features for children of different ages. For example, there is some evidence that young children attend more to the sound of a word than to its meaning. The present research does not centre on this type of question. Rather, the issue of interest is the number or range of features encoded by children to form word meaning. Adult data (Wickens, 1972, 1973) support Wickens' theory that several features of meaning are encoded at one time. The purpose of the present study is to examine whether children similarly encode several features at a time, thereby achieving a rich complexity of word meaning.

Many procedures are available for the identification of encoding dimensions. These include clustering of responses in free recall, false positives in recognition memory, rating scales and sorting tasks. These methods, however, are more conducive to the study of single attribute encoding than to an assessment of multiple encoding.

Wickens' release from proactive inhibition technique is one procedure which has been adapted to the task of assessing encoding along more than a single dimension. Very broadly, this technique allows one to manipulate the degree of apparent overlap in meaning between classes of words and to measure the subsequent sensitivity of the subjects to the differences in overlap. The semantic distance or overlap between categories is discussed in terms of features. Wickens' procedure was selected for the present investigation because of its sensitivity to feature encoding and its appropriateness for research with children. Children as young as three years of age have successfully completed a Wickens task.

In addition to manipulating the overlap in meaning of stimulus materials to determine if children can discriminate between classes of words, this thesis also investigates the variables of age and verbal ability as they relate to the encoding of semantic features. Researchers have noted considerable diversity in language skills as a function of age. Some of the literature in this area is discussed and this variable is included in the experimental investigation.

CHAPTER II

REVIEW OF THE LITERATURE

This review is divided into two main sections. The first section discusses some of the theories and findings pertaining to feature representation in children and adults. The second section is concerned with four relevant factors that have been found to affect children's processing of semantic information. These related areas of research are discussed in order to expand the base of information leading to predictions about children's encoding capacities.

An Analysis of Word Meaning

Words as Features

Anglin (1970) has defined features as the internal properties of words, a definition not unlike Vygotsky's. Although a more explicit definition may have shortcomings, one will be offered, in an attempt to clarify the meaning of this hypothetical construct. The writer proposes the following definition:

> Features or attributes are those dimensions of an object or idea that combine to form word meaning.

Vygotsky (1962) was probably the first linguist to discuss word meaning in terms of features. He described children as explaining the names of objects by their features or attributes; for example, an animal might be called a cow because it had horns. Vygotsky proposed that a word referred to a group or class of objects, not a single object and therefore word meaning resulted from a combination of features.

Support for this conception of word meaning has been growing in the past two decades. In 1957 Osgood proposed that certain classes of word meanings could be represented by a point in three-dimensional space, where the axes of the space were the connotative characteristics of Evaluation, Potency and Activity (Wickens, 1972). Since then, Bower (1967), Underwood (1969), Anglin (1970), Bregman (1968), Clark (1973), Rosch (1973, 1975), Smith, Shoben and Rips (1974), Collins and Quillian (1969, 1972), Wickens (1970) and Wickens, Dalezman and Eggemeier (1976) have all analyzed word meaning in terms of component features.

Since features or attributes have been found useful in analyzing word meaning, some examples of possible features will be suggested. It is not too difficult to postulate features for words denoting real objects. The meaning of the word "apple" might result from a combination of the following features: edible, sweet, sometimes red, round in shape, grows on trees, perceiver likes it. It is more difficult to list features for words which have an abstract meaning. The meaning of the word "beautiful" might result from a combination of the features: pretty, pleasant for viewer, and peaceful. It is suggested that the features which combine to eventuate in word meaning are influenced by the context, particularly for words that are more abstract in meaning. The features encoded in one instance do not necessarily represent all the features of meaning for a particular word.

Theories of Feature Representation

Having established the validity of viewing word meaning in terms of features, some of the theories describing the organization of features in memory will be examined. Smith, Shoben and Rips (1974) describe two kinds of models of semantic memory which present somewhat different explanations of the organization of features; these are network and set-theoretic models.

The work of Collins and Quillian (1969, 1972) denotes a network model where words are represented as independent units in semantic memory which are interconnected by a network of labelled relations. They hypothesize a hierarchically organized memory structure with certain features or relations stored at an instance level (for example, canary), while other features are stored at a superset level (for example, bird).

Collins and Quillian's proposition that words cohere in a hierarchically organized system is also advocated by Mandler (1967) and Bower, Clark, Lesgood and Winzenz (1969). These researchers have advocated that efficient cognitive processing derives from a model in which memory is hierarchically organized. While the present research is not discussed in terms of a network model, the categories which were presented to the subjects can be arranged into a hierarchically ordered system and some interpretation of the results follows this line of reasoning.

Smith, Shoben and Rips. Smith, Shoben and Rips (1974) contrast theories stressing network structures to models described as set-theoretic. They state that in set-theoretic models, concepts such as canary and bird are represented by sets of elements: "The elements might be unique descriptions or images of exemplars, attributes, names of subsets or supersets or some mixture of these types" (p. 215). The models of Wickens, Anglin and Rosch would fall into this category along with Smith et al.

Smith et al. consider the most important set-theoretic models to be based on attributes or features. The basic assumption of the Smith model is that the meaning of a word can be represented by a set of semantic features. An additional tenet of the model is that features differ in terms of how essential they are to a concept's meaning. Defining features are relatively essential whereas characteristic features are more incidental. When categorizing, the defining features are given greater emphasis. However, characteristic features play an important part in determining the centrality or typicality of a particular category member. For example, size might be a characteristic feature of the word bird so that robin might be considered a more typical bird than duck.

Smith, Shoben and Rips have obtained considerable data supporting their theory. By measuring reaction time, they have found some category members are more typical or central than others and through multidimensional scaling techniques have identified certain central features of several categories.

Rosch. The theory and research of Rosch (1973, 1974, 1975) agrees with many of the findings of Smith et al. while additionally considering how features are acquired and represented in the formation of children's noun categories. Rosch's research extends the study of "typicality," a concept which plays an important role in the present experimental investigation.

A basic recognition in Rosch's theory is that categories are not formed arbitrarily, but reflect real consistencies found in the environment. She states that attributes of the "real-world", unlike those frequently presented to subjects in the laboratory, do not occur independently of one another. Certain attributes are more frequently found together (for example, wings and feathers) than are others (for example, wings and scales).

A second claim of her theory is: "that, of the many levels of abstraction at which any given thing can be classified, there is one basic level of abstraction at which the organism can obtain the most information with the least cognitive effort" (1974, p. 52). Stated differently, in a hierarchical nomenclature describing a particular object, there is one basic level at which the item is most frequently labelled or grouped; if shown an apple one is apt to label it apple and not fruit. Rosch has identified basic level items for six different categories and has given subjects, aged 3 years to adult, sets of pictures of common objects which could be organized at basic or superordinate levels. At all ages, groupings of basic level objects occurred more frequently than groupings of superordinate objects. Also, names of basic level objects were found to be learned first by a young child as measured through a protocol of the child's speech. Rosch concludes that the traditional differences[1] often found between the sorting behaviours of adults and children are a result of the content of the tasks, not the form of the children's thinking. Children do categorize by taxonomy.

A third tenet of Rosch's theory argues that there is a difference between the formal and psychological aspects of categories; formal definitions may not correspond exactly to the psychological meaning. She states that within a given category, certain instances are considered by adults and children to be more focal than others and she attributes the choice of prototypes to extra characteristic features attached to these instances. This third assumption refers to groupings of items above the basic level, as in the example of grouping banana, grape and apple together as fruit. Some members of the fruit category are considered to be better members than other fruit items. Rosch (1975) has found that adult subjects are willing to rate items on how typical they are of a category and these ratings were found to correlate highly with Battig and Montague (1969) category norms[2] for these items. By using these ratings, Rosch has found both children aged 9 to 11 years and adults, to be more rapid in judging central examples of a category to be a category member than peripheral examples. It was also found that the children had learned the central category members better and earlier than the peripheral members; that is, children made more errors in judging category membership with peripheral than central instances.

---

[1] Children are often described as sorting according to non-taxonomic criteria, for example, forming chain associations.

In summary, Rosch finds young children do categorize, but at a basic level and that basic level items are learned first by children. When children start to learn larger, more abstract groupings, they first learn the prototypes of these categories, with peripheral members added later. Rosch suggests that if children are presented with clear examples of categories, they will make judgements about category membership in a fashion similar to adults. Differences between adults and children occur when judgements about peripheral category members are required.

The findings of Rosch and Smith et al. concerning central category members are very relevant for any investigation comparing the categorizations of adults and children. Since children appear to learn peripheral category members later than central members, they will automatically be placed at a disadvantage if presented with peripheral members. Awareness of these differences between central and peripheral category members influenced the selection of stimulus materials for the present investigation. Since the goal of the research was to determine children's capacity for encoding multiple features, it was essential that the words be well known to the children. In keeping with Rosch's evidence, an attempt was made to select central category members as stimulus items.

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[2] The Battig and Montague norms rank items, which are classified by category, according to the frequency with which the examples were listed, by a large sample of subjects, as belonging to the category.

Clark. Clark's (1973) "Semantic Feature Hypothesis" offers quite a different picture of feature acquisition from the model proposed by Rosch. Clark, in agreement with McNeil (1970), states that when a child first begins using a word, he does not possess the full, adult meaning. Perhaps only one or two of the adult's features are initially acquired. Clark presents evidence indicating that when children are adding features to word meaning, they progress from more general to more specific features. She suggests that if the features relate to each other hierarchically, then the order of acquisition of features is from the top down. For example, for the word pear, the child might first acquire the feature "food", second the feature "plant" and third, the feature "fruit". Concomitantly, the child would slowly begin to differentiate food into types, for example meats and fruit and then divide these groupings into subgroupings such as meats and fish, fruits and vegetables. The difference between the child's and the adult's categories at this stage is that the child's categories are generally larger than the adult's since he uses fewer features criterially in forming groupings. Children overextend the meanings of categories.

Clark also predicts that at some time children will regard words sharing a number of features, as having the same meaning. She gives as an example the words "brother" and "boy" which overlap considerably in meaning. If "brother" is seen as a subcategory of "boy", then some extra defining features of "brother" need to be added to the list of features for "boy" in order to make distinctions in meaning. Before acquiring these distinguishing features the two words would have equivalent meanings. The concepts "fruit" and "vegetable" might be similarly mistaken, although they do not relate to each other hierarchically. Clark asserts that after the child has attached some minimal set of features to a word, the word's meaning is defined by that minimal set and the child is not aware that his meaning differs from an adult's.

Clark's hypotheses are based on diary studies of children first acquiring speech. She has applied them, however, to the analysis of children's comprehension of word meanings up to the age of twelve years (Clark, 1973).

Huttenlocher. Huttenlocher (1974) approaches the subject of word meaning by differentiating between receptive and productive language. She concludes from her research on early language development that:

1. Receptive language is considerably in advance of productive language at least for very young children.

2. There is no simple relation between a child's systematic response to the words he hears and his production of words.

Huttenlocher discusses Clark's (1973) feature acquisition hypothesis from the viewpoint of receptive and productive language. She studied comprehension in young children and found very few overextensions in meaning; children typically did not respond to a word unless they knew its referent. However, some overextensions in meaning were evident in children's production of speech.

In contrast to Clark's suggestion that children are not aware of incomplete meanings, Huttenlocher proposes that children do know when they use words incorrectly. Huttenlocher also suggests that for certain categories like apples, cookies and shoes there is little evidence of a shift in meaning over age or that children's words have fewer features of meaning than adults. This finding is consistent with Rosch's research of central category members; that is, children are as familiar with certain well-known words as adults.

In summary, many theorists consider that word meaning can be represented by lists of semantic features. There is evidence that word features are stored in an organized way in semantic memory and are not just haphazardly or arbitrarily arranged. Clark (1973), McNeil (1970) and Rosch (1973, 1975) discuss children's acquisition of semantic features and how the meanings and classifications of words change with the addition of features. McNeil (1970), as well as Clark (1973), emphasize differences in comprehension of word meaning by adults and children, with children gradually acquiring additional features and approaching an adult's understanding of word meaning. Rosch (1973) and Huttenlocher (1974) emphasize similarities in comprehension between adults and children, while acknowledging that differences also exist. Rosch differs from Clark by distinguishing between typical and atypical category members and finding children to be comparable to adults in their understanding of typical members. Huttenlocher contrasts with Clark by differentiating between comprehension and production of language and noting similarities between adults and children in their comprehension of word meanings.

The theories considered so far have been concerned with the acquisition and organization of features in semantic memory. The discussion will now turn to the research investigating the encoding of semantic features. Encoding is the process by which the attributes of a memory are established. It refers to the translation of external information into internal information or the entry of words into memory (Underwood, 1969). In the following discussion, attention will be paid to the types of features encoded by adults and children as well as the number of features processed at one time.

Wickens. Wickens is one of the leading researchers in the field of word encoding. He presents evidence supporting his theory of complex information processing of single words by adult subjects (Wickens, 1970, 1972; Wickens et al., 1976). He feels that many attributes of word meaning are salient for the human perceiver and that words are encoded along a multiple number of dimensions or psychological categories at one time. He considers that the person perceiving and encoding the information is frequently unaware at the conscious level of the ways in which the information is being encoded and suggests that man could not function effectively if he was aware of the richness of his perceptions.

There are many mediating processes such as visual mental imagery, sentence formation, word associations and rhyming which a subject might use in order to remember a piece of information. Wickens' research does not focus on what Flavell (1970) terms planful mediational processes by which the subject enters an item into memory. In fact, Wickens' technique attempts to prevent the subject from making such kinds of elaborations. Rather, Wickens is interested in studying which and how many features of a word's meaning are automatically activated by subjects.

His method grew out of the Keppel and Underwood (1962) research on proactive inhibition in short-term memory which indicated that the Peterson and Peterson paradigm (which presents an interfering task between presentation of stimulus items and their recall) was subject to proactive interfering effects. Keppel and Underwood defined proactive inhibition as the interference of prior learning on the retention of subsequent items. Wickens, Born and Allen (1963) presented evidence indicating that the proactive inhibition was specific to the class of material presented. Their experiment built-up interference for three-digit numbers or consonant trigrams and then switched the class of material, numbers to trigrams and vice versa. There was great improvement in recall on the trial when material was shifted from one sort to another. Since this initial experiment, Wickens has documented many classes of material that are subject to the build up and release of proactive inhibition (PI release).

Wickens explains these findings by hypothesizing that elements (words, numbers, letters) which are homogeneous with respect to class are encoded not only as individual items but also as members of the same semantic category. When several items are chosen from the same category, many common features are encoded for the different words and as a result there is interference in memory leading to poorer recall. However, if a new set of items is chosen from another category, interference is reduced (new features are encoded) and retention improves. Wickens attributes the reduction in interference to differential encoding of the new items and terms the resulting improved retention "release from proactive inhibition". Wickens (1973) suggests that if one accepts the hypothesis that differential encoding improves performance, then the technique can be used for investigating whether formal classes of materials are functionally encoded in different ways by subjects.

Dominance of Features

Wickens' research has focused on discovering the features or attributes of word meaning which are encoded by adult subjects on a short-term memory task. Wickens has found that all changes in materials do not produce release effects or to the same degree. His results have suggested that shifts in the semantic attributes of words produce good PI release while shifts in the grammatical features and in the methods of the physical presentation of the words (other than cross modality presentation) produce little or no release. In addition, researchers have found subjects to be sensitive to word frequency, the language of presentation if the subjects are bilingual and whether visually presented digits are shown as numerical symbols or in word form.

Wickens' procedure has also been successful in identifying many features of word meaning encoded by children. Children have been found to be sensitive to shifts in taxonomic categories (Hoemann, DeRosa & Andrews, 1974; Libby & Kroes, 1971; Kail & Schroll, 1974; Pender, 1969), to contrasts of words with masculine or feminine connotations (Kail & Levine, 1974), to shifts in the acoustical features of words (Pender, 1969) and to contrasts of positive and negative poles of the evaluative dimension of the semantic differential (Pender, 1969). Words and pictures have been presented visually as well as words auditorally.

Hagen, Jongeward and Kail (1975), after considering the children's findings on the release from PI technique, noted that the developmental differences shown by children reflected the salience of attributes encoded by adults. Variables which produced very strong effects in adulthood emerged developmentally at an earlier age than variables which were less potent for adults.

Investigations of the encoding attributes which are salient for children have used methods other than the Wickens technique. Some of the literature applying different research methods to this question will now be considered.

Underwood (1969) proposed a developmental sequence of attribute dominance. He suggested that acoustic and spatial attributes might be acquired first by children and that verbal attributes might become more common as a result of schooling. Underwood and others have tested for the possibility of developmental changes in attribute encoding by using a false recognition paradigm. With this technique, an encoding attribute is detected when children falsely recognize words having a particular relationship to key words. Bach and Underwood (1970) found 7-year-olds made more false recognition errors to acoustically similar words than to associatively similar words. This pattern was reversed for 12-year-olds. Freund and Johnson (1972) felt orthographic similarity might have produced the Bach and Underwood results. By selecting words which were either orthographically, acoustically or associatively similar to key words they found 6-year-olds gave most false recognitions to orthographic foils. Eight-year-olds and college students falsely recognized all three categories of words more than control words. In another investigation, Ghatala and Hurlbut (1973) found a decrease in acoustic and an increase in associative errors with age.

Lappert (1974), using a free recall procedure, tested third and sixth grade children with three lists of words which were organized according to concept, acoustic similarity or were unrelated. Acoustically and semantically related lists were recalled better than unrelated lists. Grade 3 children recalled acoustically related lists better than semantically related lists and grade 6 children showed the reverse pattern. Hasher and Clifton (1974) gave a list of twenty words to children in grades 2 and 6 for free recall. Embedded in the list were four critical words which were either massed or distributed, and either phonemically or semantically related. Both second and sixth grade children recalled massed phonemic and semantic words better than control words. They differed only on the distributed words with second graders recalling phonemically related words better than control words and sixth graders recalling semantically related words better than control words. Felzen and Anisfeld (1970) obtained similar results with children from grades 3 and 6. Employing a false recognition paradigm, all children gave more erroneous "old" responses to words which were phonetically or semantically related to previously heard words than to control words. Similarly, Hall and Halperin (1972) found four- and five-year-olds falsely recognized acoustically similar and associated words more than control words, with no differences noted between the two kinds of related words.

From the studies considered in this section it can be seen that children, as well as adults, attend to perceptual, acoustic, orthographic and semantic features of word meaning. Some studies have found nonsemantic features to be more important in children's categorizations than adults' categorizations. These same studies, however, often report that both adults and children have attended to semantic features at least as much as to nonsemantic features. Differences in performance between adults and children might result from their relative degree of distractability by phonemically related words. However, this does not mean that children are less sensitive than adults to word meanings.

Multiple Encoding

Having determined that children, as well as adults, encode word features, the discussion will now turn to an analysis of the number of features encoded at one time. As indicated earlier, this forms the focus of the present research.

For the past decade, Wickens (1972, and Wickens et al., 1976) has been concerned with an assessment of the multiple encoding skills of adult subjects. As previously mentioned, Wickens hypothesizes that subjects encode many features of word meaning at one time. However, the conclusions regarding salient encoding features reported in the previous subsection result from studies where only values along single dimensions were manipulated. For example, words with masculine connotations were contrasted with words of feminine connotations and words high on the evaluative scale of the semantic differential were contrasted with words low on the same scale. However, these two variables were not manipulated concurrently so one cannot say that a subject encodes simultaneously the evaluative connotation of a word as well as its masculine or feminine implication.

Although Wickens has long postulated that the human perceiver encodes on multiple criteria, it was not until more recently that he produced evidence to support this hypothesis. Goggin and Wickens (1971) investigated the effect of a Spanish-English language shift, in combination with a concept shift, in bilingual adults. They found the double shift produced greater PI release than either single shifts, which were in turn superior to the no shift conditions (control groups). This study showed subjects to be sensitive to the degree of feature overlap between pre- and post-shift categories: the more features that were changed on the shift trial, the more release obtained by the subjects.

Hopkins, Edwards and Gavelek (1971), using the PI release paradigm, shifted the category of the items and the modality of presentation, both separately and in combination. They found the double shift produced

100% release and the single shifts about 65% release each.

Eggemeier (cited in Wickens, 1972) compared the effects of single and double shifts within the dimensions of the semantic differential. Again double shifts produced greater release than single shifts, which were superior to no shifts.

Recent research by Wickens and Eggemeier (in Wickens, 1973) and by Wickens, Dalezman and Eggemeier (1976) approached the question of multiple encoding from a different viewpoint, studying the relationship between the degree of overlap in meaning of two categories of words and the ensuing degree of PI release. They chose as a constant fourth trial (that is, the shift trial) items from the class of fruits. Four different experimental groups were presented with words chosen from one of the categories of meats, vegetables, flowers or professions for the first three trials. A control group received items from the fruit category for all four trials. A schematic analysis of the interrelationships of these categories might include the following features: vegetables and fruits share two major attributes, both are edible, both are plants; meats and fruits share one major attribute, both are edible; flowers and fruits share a different attribute, both are plants; fruits and professions share none of these attributes. The experimenters predicted and found the following significant shift effects: profession > meats = flowers > vegetables > fruits. Adult subjects were shown to be very sensitive to the degree of overlap of semantic features, and appeared to be encoding at least four features (edible, where grown, type of plant, item name) on this short-term memory task.

This analysis of feature overlap does not show the total number of features combining to form the meaning of each category label, nor the number of shared or differing features between combinations of categories. It is offered as a simple description of the obvious overlap between the categories.

Support for this analysis of the overlap in meaning of these concepts is gained from a sorting task conducted by Collen, Wickens and Daniele (1975) where hierarchical relations among taxonomic categories were determined and compared. College students were presented with the 57 category names of the Battig and Montague (1969) norms, printed on cards, plus the category name "Meat". The subjects were asked to sort the categories into piles of cards that belonged together. Considering just the categories of Wickens, Dalezman and Eggemeier's investigation, the following percentages were obtained for the sorting of the various clusters together: vegetables and fruits were clustered by 95% of the students; vegetables, fruits and meat by 70% of the students; vegetables, meat and occupations by zero per cent of the students. These sortings are consistent with Wickens, Dalezman and Eggemeier's interpretation of large overlap in meaning between fruits and vegetables, intermediate overlap between vegetables, fruits and meats and little overlap between vegetables, meats and occupations.

Wickens, Dalezman and Eggemeier have presented evidence supporting Wickens' contention that adult subjects multiply encode features of word meaning. Whether children have a similar capacity for multiple encoding is the main question of this thesis. The author is unaware of any developmental literature concerned with this issue and therefore the predictions about children's possible capacities for multiple encoding are based on related areas of research.

How Children Organize Information

It is often said that young children are more concrete and less abstract in their understanding of word meanings than older children and adults. In order to comprehend this assertion, one must first come to an agreement on definitions for the words concrete and abstract.

Abstractness is frequently defined in terms of a hierarchical model, in which a superordinate item (that is, an item higher in the hierarchy) is considered to be more abstract than a subordinate item (Anglin, 1970). When abstractness is considered in this way problems are encountered if the items to be related can not easily be organized into the same hierarchical tree-like structure.

The terms concrete and abstract can also be described from the viewpoint of degree of feature overlap. For any combination of words or categories, the fewer features shared by the constituents, the more abstract the relationship between them, and conversely, the greater the overlap in features, the more concrete the relationship. This definition was preferred by Anglin (1970) in his study of lexical development. It does not negate the concept of nested features or the hierarchical interrelationship of words; however it does not require this type of relationship among constituents in order to define degree of abstractness.

A third dimension of the concept of abstractness is offered by Klausmeier, Ghatala and Frayer (1974) who have argued that abstract words and concepts have fewer perceptible instances and fewer common attributes that are perceptible, than concrete items. If one were to compare the relative abstractness of the words "travel" and "farmer", travel would be considered more abstract as it has fewer perceptible attributes than farmer. Klausmeier et al. (1974) suggest that the learning of abstract labels is heavily dependent upon language and that these labels may be more difficult for children to learn than concrete labels, because of the demand for language sophistication. This suggestion is consistent with observations made by Brown (1958) and Bruner, Olver and Greenfield (1967) who noted children's reliance on the perceptible properties of referents.

Combining the definitions of Anglin and Klausmeier et al. one can see that a categorization of items like banana, peach and pear together as fruit is an abstraction or generalization that is quite concrete in nature. These items share many common perceptible features. A grouping of banana, grass and fly together as "living things" is quite abstract; the shared features are minimal and mostly imperceptible.

Defining abstractness in terms of feature overlap would appear to be as appropriate as would a definition based upon hierarchical relationships. For this thesis, because of the nature of the relationships between categories, the feature overlap definition is preferred. However, some analysis of the hierarchical relationships between the categories investigated in this research will also be considered.

We will now return to the original proposition that children exhibit a concrete to abstract developmental progression. If children are concrete in their thinking, they probably attend to perceptible features (Klausmeier et al., 1974; Bruner et al., 1967; Brown, 1958), group objects and words together which overlap considerably in meaning (Anglin, 1970) and learn subordinate members of a hierarchy before superordinate members (Anglin, 1970; Rosch, 1973). There is evidence supporting this depiction of children's processing capacities.

Concrete to Abstract Development

Through sorting experiments, free recall and free association experiments, and clustering studies, Anglin (1970) has researched extensively the incidence of concrete and abstract groupings of words by adults and children. The main findings of his research will be briefly summarized.

1. Between the ages of five and ten years, he noted a syntagmatic to paradigmatic shift in categorizations. Syntagmatic categories can be loosely described as grammatical matches where words of different parts of speech are grouped together, often forming sentences. These groupings are frequently thematic in nature. Paradigmatic groupings are semantic matches or true categorizations of words of the same parts of speech. Over grades 3 to 4, 7, 11 and into adulthood, Anglin found syntagmatic responses decreased and paradigmatic responses increased.

2. The more abstract the relationship between two words, the less they were grouped together by adults and children. When concrete groupings could be formed, adults and children made quite similar responses. For example, boy and girl were nearly always grouped together by both age groups. As the relationships between the words became more abstract, the sorting behaviours of adults and children increasingly differed; children did not tend to group together words that were abstractly related. Anglin considered these findings to support a generalization hypothesis; that is a developmental progression from concrete to abstract thinking occurring over the childhood years and into adulthood.

Bruner and his associates (1967) have also documented the dependence of young children on concrete, perceptible features with a development towards more abstract representation. He labelled the concrete mode of representation "ikonic" and the abstract mode, "symbolic". Bruner (1964) has indicated that around 8 to 9 years of age the child is in a transition stage between ikonic and symbolic processing, with the symbolic stage evident in 12-year-olds.

Russell and Saadeh (1962) presented 3rd, 6th and 9th grade children with forty items and definitions. They found a decrease in the choice of concrete definitions and an increase in abstract and functional definitions at each higher grade level, with the biggest change noticed between the 3rd and 6th grades.

Palermo (1971) conducted a word association test with children in grades 1 to 4. Combining his results with previous findings, he concluded that there is an increase in strength of associative connections and in paradigmatic responses from grades 1 through to college.

Gamlin (1976) asked children in grades 3, 5, 7, 9 and 11 to match literal and abstract paraphrases to proverb sentences. Accuracy for matching abstract paraphrase representations to proverbs increased as a positively accelerating function from grades 3 to 9. Accuracy for matching literal paraphrase representations was high in grade 3 and increased slightly from grade to grade through to grade 9.

Abstract to Concrete Development

While there is considerable evidence supporting a concrete to abstract developmental continuum (Anglin, 1970; Bruner, 1964; Klausmeier et al., 1974; Gamlin, 1976) this analysis does not describe completely what is being learned during childhood and into adulthood. As noted in the first part of this chapter, Rosch (1973) has determined a basic level at which certain concepts are first learned and has shown that children subsequently acquire both superordinate and subordinate terms. For example, Rosch cites "apple" as a basic level item with fruit as a superordinate and Mackintosh as a subordinate. If word meanings change through the acquisition and deletion of features, then features specific to "Mackintosh" would have been added to the feature list of "apple", and features specific to "apples" but not "fruit" would have been deleted from "apple", to form the subordinate and superordinate terms respectively.

Support for the acquisition of features which subcategorize is provided by Clark (1973) who focuses on this aspect of lexical development. She considers features to be acquired from the top down, with features being added in order to make finer and finer discriminations in meaning.

Winters and Brzoska (1976) presented coloured slides of picturable objects to children in kindergarten, grade 4 and grade 9 for labeling and categorizing. As age increased, more categories and superordinates congruent with adult criteria were generated and differentiation within categories increased. Neimark (1974) also found that as mental age increased, concepts became more limited and definitive. These findings are consistent with increasing subcategorizations with age.

Nelson (1974) presented nine category labels to 5 and 8 year old children who were asked to list instances for the labels. She found an increase in the size of categories or in the number of instances listed per category, with age. It is quite possible that by adding instances, the children were adding subcategories. Nelson describes an increasing hierarchization and greater structuring of categories by older children.

These studies present evidence to suggest that children's word meanings develop both towards greater abstractness and greater concreteness.

Although some researchers emphasize only one aspect of this development, others such as Rosch have discussed the two processes as co-occurring. Her position has since been supported by Anglin (1977).

The "concrete to abstract debate" presents a global picture of much of the research concerned with children's understanding of word meaning. There are two main points raised by this research which pertain to the present thesis:

1. Younger children have been found to be as capable as older children and adults on tasks requiring categorizing of concrete words. This thesis does not investigate the "concrete to abstract continuum" but controls for this phenomenon by presenting concrete, picturable words which are grouped into concrete, familiar categories.

2. Bruner et al. (1967), Russell and Saadeh (1962) and Anglin (1970) all noted considerable differences between 8 and 11 year old children in categorizing abilities. These age levels coincide with Piaget's concrete and formal operational stages respectively and also denote the two age groups of the subjects in this thesis.

Clustering Studies

Clustering of responses by category during recall has been used as an indication of conceptual organization in children and adults. Some clustering studies will be discussed in order to view similarities and differences between children and adults on these tasks, and to establish the validity of presenting children with words organized according to adult categories.

Moely, Olson, Halwes and Flavell (1969) presented children in kindergarten, grades 1, 3 and 5 with twenty-four object pictures, 6 in each of 4 categories, for recall. Basically, only the grade 5 children showed categorical clustering. Neimark, Slotnick and Ulrich (1971) also found little categorical clustering with children in grade 1 while noting an increase in clustering responses over grades 1, 3, 4, 5, 6 and college.

Arlin and Brody (1976) presented categorically blocked and unblocked lists of words to children in grades 4, 6 and 8. All grades were equally unable to cluster by category the unblocked presentations. With blocked presentations, clustering significantly increased with age.

Denny and Ziobrowski (1972) found adults clustered according to similarity relationships (king and ruler) and grade 1 children clustered according to complementary relationships (pipe and tobacco). They did not find clustering to increase with age but rather that subjects of different ages clustered according to different rules.

In contrast to these findings that young children exhibit little categorical clustering, Rossi and Rossi (1965) and Rossi and Wittrock (1971) found children of two years of age to be clustering at a level significantly above chance. Similarly, Goldberg, Perlmutter and Myers' (1974) results indicated that children of age two recalled related objects better than unrelated objects. In addition, Worden (1974), Huttenlocher and Newcombe (1976), Westman and Youssef (1976) and Steinberg and Anderson (1975) all noted that organizing a list of items by category improved the recall of children over the age range of three and a half years to adulthood. Worden concluded that children, like adults, find it easier to memorize words organized into many small groups, with subcategories and superordinates, than into a few large groups.

Huttenlocher and Newcombe (1976) have found the effect of blocking to occur at very fast presentation rates (four items per second) suggesting that at least some aspects of memory are accessed rapidly on presentation. They have proposed an automatic activation hypothesis in which the effects of meaning relatedness result from automatic processes based on structural aspects of the organization of semantic memory: "activation of a particular item automatically produces a temporary excitability in semantically neighbouring items" (p. 397). According to this hypothesis, the effect of semantic relatedness would be equally great whether or not subjects expected the co-occurrence of related words.

In summary, while there is evidence supporting development in categorizing skills as a function of age, there is also a large body of research which supports the assertion that even very young children organize information according to taxonomic criteria. This latter finding is consistent with Vygotsky's description of the development of children's concepts and should not be too surprising considering the social nature of language learning. Children learn through contact with adults the methods of categorizations appropriate for their culture. Children and adults understand one another while not possessing identical meanings for words. To present children with words grouped according to adult criteria and to expect the children to understand the bases of these groupings, is a valid objective if the categories and examples to be used as stimuli have been selected appropriately.

Strategies

In addition to studying how children respond to lists of items organized according to adult criteria, considerable research has been devoted to the study of the subjective organization imposed by children upon stimulus material. Differences in the rehearsal strategies employed by younger and older children are often felt to be responsible for the better recall of older individuals.

Liberty and Ornstein's (1973) sort and recall task yielded results which showed that fourth grade children and college students produced reliably different sorting patterns for 28 high frequency nouns. Fourth grade children showed less sorting on the basis of word meaning and greater variability between subjects than the adults. When additional grade four children were yoked to college students, requiring the learning of the latter group's sorting patterns, the children in fourth grade showed improved recall. When college students were similarly yoked to the fourth grade children, their recall deteriorated. The researchers concluded that changes in organization produce changes in recall; also, the organization imposed by college students was more conducive to recall than that invoked by the younger subjects.

Lange and Jackson (1974) also employed a sorting-recall procedure to explore age-related characteristics of children's personal categorizing schemes. Subjects from grades 1, 4, 7, 10 and college attained stable free sorting categories prior to free recall. At recall all children made substantial reference to previous sorting schemes. Younger children formed smaller categories and more categories than older subjects. Lange and Jackson concluded that many experimenter defined categories for clustering are insensitive to children's categorizations.

From the studies just mentioned, it can be seen that young children do organize information presented for recall; however, their method of organization is frequently different from that of older children and adults. It also was shown that the organization imposed by adults is more conducive to recall, for both adults and children, than children's organization. However, children can be taught more efficient ways to retain information. Many attempts have been made to try to train children in recall strategies.

Keeney, Cannizzo and Flavell (1967) and Moely, Olson, Halwes and Flavell (1969) found they could train children to rehearse when they had not previously done so, thus producing an improvement in recall. However, when no longer constrained to rehearse by the experimenter, 59 per cent of the original nonrehearsers reverted back to their earlier behaviour. Similarly Moely and Jeffrey (1974), Lange (1973) and Lange and Hultsch (1970) found they could train young children in methods of organizing information in order to improve recall. Some of these researchers also found that trained children would revert back to previous strategies when unconstrained by the experimenter. Hagen (1971), after conducting a series of studies on the effects of induced labelling and rehearsal, concluded that with age, children increasingly rely on the use of their own rehearsal strategies to perform on memory tasks. Induced labelling in 10-year-olds actually interfered with recall because it interfered with the children's personal strategies of active rehearsal.

In summary, young children of 5 and 6 have not been found to rehearse actively when trying to remember lists of items. If taught by the experimenter how to rehearse or organize information, recall of young children has been greatly improved. When the experimenter imposed constraints have been removed, nonrehearsal frequently has resumed.

Differences between younger and older children in their recall behaviour, both in the degree of categorical clustering and the total amount recalled, can often be traced to differences in rehearsal strategies; with age children are able to utilize more effective strategies. In the present research these differences in ability are controlled for, as much as possible, by requiring all subjects to perform a rehearsal preventative task between presentation of stimulus items and recall of the information. Wickens' research with adults has employed this procedure and it allows comparison of the encoding skills of groups of subjects of different ages without the confounding influence of differential rehearsal strategies.

Number of Features Processed

The foregoing discussion has focused upon several studies relating to the kinds of semantic features attended to by children and adults. It is also important to consider how age relates to the number of features of word meaning processed at one time. As noted in the section on multiple encoding which appeared earlier in this chapter, the author is unaware of any literature addressing this question directly. There is, however, a large body of literature which researches the scanning strategies employed by children when processing perceptual features. This literature indicates a growth in children's ability to discriminate and process perceptual features as a function of age. The older the child the more features managed at one time.

Case (in press), in explaining Pascual-Leone's memory capacity or "m-space" construct, has stated that "m-space" increases as a function of age. Case has found a systematic increase in the number of phrases which children can repeat as they progress from three to nine years of age. On his task, at every two year interval the "m-space" increases by one unit, starting at age three when subjects can repeat one phrase and finishing at age nine when children can repeat four phrases.

Russell (1956) has discussed research conducted by Welch and Long in the 1940's which pertains to the question of the number of features attended to at one time. These studies emphasized the hierarchical relationships involved in children's concepts. Children were first found to grasp the hierarchical nature of word meanings around 26 months of age, when they could understand, for example, that men and women were people. The second stage in hierarchical development was found to occur around four and a half years. These children understood relationships like food-vegetable-potato and food-fruit-apple. In Welch and Long's final stage, children were able to master from 4 to 9 steps in a hierarchy. Welch and Long's developmental hierarchy offers support for the hypothesis of an increase in the number of features attended to by children as a function of age. Increased comprehension of features of meaning allows children to subcategorize and to generalize relationships.

In summary, there are many studies supporting the contention that the more features a young child has to attend to in order to solve a problem, the more difficult is his task. Piaget has noted that as the child's logical abilities develop, his method for choosing criteria become more complex. He has described a developmental progression which shifts from attention to single attributes, to combinations of attributes, in order to form successive classes (Piaget, in Kofsky, 1966). Piaget's description and the research findings discussed are all consistent with Anglin's (1970) generalization hypothesis which describes a growing complexity in children's concepts as a function of increasing age. Complexity comes from an understanding or apprehension of several features at one time. Predictions based on these findings would forecast differences in children's ability to encode multiple numbers of features as a function of age.

Task Effects

Anglin (1977) has noted that the:

> situation in which a child is studied will often determine whether or not a developmental psychologist will be willing to attribute to him a given ability or skill. . . . Very young children will often demonstrate the kinds of skills once believed to be beyond their ken, provided one looks in the right places for them. (p. 24)

Klausmeier, Ghatala and Frayer (1974), in their study of concept development, have noted differences between consecutive levels of concept attainment which pertain to this issue. Klausmeier at al. view the development of concepts as a slow continuous process and have defined four levels of concept development. The last two levels of their model will be described in order to indicate how task requirements might influence the conclusions reached by researchers. At the third or classificatory level, the child can generalize two or more instances of the same thing as being equivalent in some way; however, it is not until the fourth or formal level that the child can define the relevant and irrelevant attributes of this generalization. From this one can see that the child might be able to group items according to a certain principle successfully without being able to give an adequate formal definition of the concept; therefore many children who possess considerable knowledge of a concept will be unable to give evidence of their comprehension if the task requires formal definitions.

This concludes the presentation of research on "How Children Organize Information". The research under this subheading was divided into four main subsections: the concrete to abstract debate, children's understanding of adult categories, children's use of strategies and children's processing of multiple features. The literature which was reviewed can be generally divided into two basic positions. A large body of research documented developmental differences in cognitive processing and language skills with increasing age. Literature was also discussed which suggests that on many tasks, children and adults exhibit comparable skills, employing the same kinds of categorizations to organize semantic information. There are definitely differences in the processing capacities of adults and children, but children do exhibit considerable competence in their mechanisms of categorizations and concept formation. Whether evidence of this competency is obtained in an experimental situation depends greatly upon the nature of the tasks presented to the children.

Summary

This chapter was divided into two main sections. The first section considered research concerned with a featural analysis of word meaning. The second section considered developmental research into other areas of cognitive processing. The research in both sections can be divided into two main positions. One body of research emphasized developmental differences in processing capacities, both in the number and type of features processed at one time and in the complexity of information manipulated, as a function of increasing age. The second body of research focused on similarities in the processing skills of adults and children. Two different conclusions emerged from these positions and constituted the main investigation of the study:

1. Based on the research noting developmental differences as a function of age, differences in children's ability to encode multiple features might be predicted for two different age groups.

2. Based on the research suggesting considerable overlap in skills for children and adults, another tenable prediction might be that both

younger and older children would show competence in multiple encoding.

The thesis is not designed to test the validity of one of these theoretical positions over the other. Both similarities and differences between children and adults in cognitive processing and language behaviour have been well documented. Rather, the focus of the thesis is a determination of which of these two descriptions is appropriate to children's encoding of word meaning.

In order to investigate these opposed theoretical positions as they relate to children's capacity for multiple encoding, it was necessary to control for one significant factor. If multiple encoding was to be established it was first necessary that multiple features be attached to a word's meaning in memory. Consistent with the literature on feature acquisition it was expected that well-known words would be represented in memory by more comprehensive feature lists than less familiar words. For this reason, very common examples from four categories of words were employed as the stimulus items. If children have the capacity to multiply encode semantic features, they should be able to exhibit this skill with well-developed words. If less meaningful words were presented, fewer features would relate to the words and the children would have more difficulty exhibiting competence in multiple encoding.

This chapter has described the base of information from which the major direction of the thesis was developed. The following chapter presents a critique of the Wickens technique, an outline of the variables manipulated in the study and the specifies of the hypotheses.

CHAPTER III

CRITIQUE OF THE WICKENS TECHNIQUE AND RATIONALE FOR STUDY

Wickens' technique and research have been acknowledged by many (Underwood, 1972; Turvey, 1974; Hagen, Jongeward Jr. & Kail Jr., 1974; Solso, 1974) as forming one of the foremost and most comprehensive approaches to the study of word encoding. Although there has not been complete agreement on the explanation of his findings, his results are viewed as significant and important.

Wickens' method has been to present to the subject, for two seconds, a triad of words drawn from a common category. A distracting task is performed during a fifteen second retention interval. Recall of the triad is then requested at the beginning of a ten second recall interval. Trial 2 begins with another triad drawn from the same category. For both experimental and control subjects, the procedure continues in this manner for the first three trials. On Trial 4 the experimental group shifts to a triad drawn from a different category while the control group continues with words drawn from the same category. On a standard Wickens task, there are two experimental and two control groups, since for both experimental and control subjects half of the subjects begin trials with one class of material while the other half commences with the other class. Performance of the experimental and control subjects is compared on Trial 4, when they are recalling the same word triads and differ only in their experimental histories.

Wickens has found recall performance declines from Trial 1 to Trial 3 and he considers this to be caused by the interfering effects of proactive inhibition. When a new category of items is presented on Trial 4, interference is reduced (new features are encoded) and retention improves.

Criticisms of Wickens Technique

Underwood (1972) has criticized the technique for overestimating the number of encoded attributes by priming subjects to encode along certain dimensions. He has stated that PI release can probably be obtained for any semantic attribute which can be reliably scaled by subjects. However, Wickens has found that one variable which subjects can scale reliably (parts of speech) is not a salient encoding variable. Also, Wagner (1970) has found that college students who demonstrated PI release on a sense impression shift could not sort the two classes of words into their respective categories, without the experimenter first providing the category labels. Priming does not seem to have influenced the results of Wagner's research. Probably in many cases subjects are aware of the categorical membership of stimulus items. However, if Huttenlocher and Newcombe (1976) are correct in their hypothesis of automatic processing of semantic relatedness, then the degree of the subjects' awareness of the semantic relatedness will not influence the build up of PI.

Tulving and Watkins (1975) have criticized Wickens' findings for being applicable to his procedure only. This criticism is inaccurate for Brown and Atkinson (1974) have adapted Wickens' technique to a free recall task and obtained interesting results consistent with Wickens' findings. Subjects were presented with word lists, which were fifteen items in length, for five trials. If the words of the five lists were drawn from the same category, recall dropped off across trials. If each of the lists of words represented a different subcategory, recall was about equal for all five trials.

Schuberth, Lively and Reutener (1973) have also successfully adapted Wickens' method to a different short-term memory procedure. They studied subjects' recall of sentences while manipulating both the nature of the sentence frame as well as the semantic categories mentioned in the sentences. Subjects were presented with four blocks of three sentences. The semantic category was constant across blocks for control subjects; the semantic category and/or the syntactic frame was shifted from block three to block four for experimental subjects. The researchers found PI build up across the first three blocks and PI release if the semantic category was changed for the fourth block.

In summary, considerable research has been directed towards analyzing and assessing Wickens' technique. Although some reservations have been expressed about the method and the results, Wickens also has received widespread acclaim for the sensitivity of his technique and the interesting insights he has provided about salient encoding attributes. Tulving and Bower (1974, p. 284) conclude a critical analysis of the Wickens technique with the statement that it is "an interesting example of a technique that works although no one is sure why it does." With reservation they state that the explanation of the category shift effect in terms of attribute shifts is the most plausible one offered so far.

Analysis of PI

Extensive investigations of where in the memory system the proactive interference occurs, have been conducted by Dillon and Thomas (1975), Dillon (1973), Dillon and Bittner (1975), Checille and Butler (1975), Gorfein and Jacobson (1972, 1973), Loftus and Patterson (1975), Brown and Atkinson (1974) and Gardiner, Craik and Birtwistle (1972). By differentiating between items recalled from primary and secondary memory, using Tulving and Colotla's model of intratrial repetition interval, Brown and Atkinson (1974) and Gardiner, Craik and Birtwistle (1972) have provided evidence that the PI effect occurs in secondary memory. This finding agrees with the general assumption that semantic features are retrieved from the long-term store and not developed during a short-term memory task. A simple description of the memory process in the long-term store could include the entry or storage of information into long-term memory (LTM), with subsequent retrieval involving response generation and response selection. The effect of PI has been found to occur in varying degrees in each of these three stages. Loftus and Patterson (1975) investigated the extent to which performance decrease is due to a decrease in information being transfered to the long-term store. They conducted eight blocks of Brown-Peterson trials and then requested an overall free recall of all words previously presented. The results showed no decrease in final recall probability as a function of short-term trial number. If later items had not been stored, recall of later trials should have been poorer. The authors consider the decrease in performance to be due to increasing retrieval difficulties.

Dillon and Bittner (1975) and Dillon and Thomas (1975) describe the retrieval process as involving response generation and response selection and state that the results of Loftus and Patterson (1975) do not necessarily imply response confusion at recall. Dillon and Thomas have found through their subjects' subjective confidence ratings that prior list intrusions on a Wickens task are generally known to be incorrect. They have concluded that subjects do not confuse items from different trials, but rather experience difficulty generating the correct response.

Dillon and Bittner (1975) presented a category cue after the presentation of the last trial of a Wickens task and this cue enhanced performance whether or not there was a category shift. If there was no shift in category, the final cue could only assist response generation for it could not aid in selecting among alternatives if it was appropriate for items from all previous trials.

The gist of the research of Dillon and his associates is that difficulties in response generation are linked to earlier storage problems. That is, because items are not stored or only partially stored, it is more difficult to produce the correct response.

Chechille and Butler (1975) discuss a Bayesian statistical procedure which separates storage and retrieval. Using the Wickens technique and confidence ratings these researchers have found both the storage and retrieval components to show reliable PI build up. The PI effect in storage was much larger than the effect in retrieval and the changes in both dimensions were unrelated. However, Chechille and Butler do not define what they mean by retrieval or subdivide the concept into response generation and response selection as do Dillon and his associates.

Chechille and Butler's concluding comments offer a plausible explanation of the PI effect. They propose a two factor theory that stresses the role of competition both in making the transfer process to

LTM more difficult and in making the retrieval process at the time of recall difficult. They talk in terms of a signal-to-noise ratio, with previously heard items from the same category presenting a noisy background for future items from the category. A shift to a different category makes the new target item easily distinguished from old information, thereby increasing the signal-to-noise ratio. When there is sufficient storage, then the retrieval process at the time of test is less efficient if there are other items from the same category recently stored. A shift to a new category facilitates recall because there is only one example of the category to retrieve.

Although researchers do not totally agree on the location of the PI effect in the memory process, they all note that a shift in meaning between categories is required to produce PI release. Brown and Atkinson (1974) have investigated the uniformity of category membership necessary to produce the PI effect. Basically, PI will not build up if the items within a list (or triad) are more homogeneous than the sets of items from all lists (or triads) taken together. Not only is PI build up dependent upon common category or subcategory membership, but also the amount of PI release ensuing on the final trial is dependent upon the degree of the shift in meaning between categories (Wickens, Dalezman & Eggemeier, 1976).

This concludes the critique of the Wickens technique. Having examined some of the more technical aspects of the PI phenomenon, the discussion will now return to the particulars of the present study.

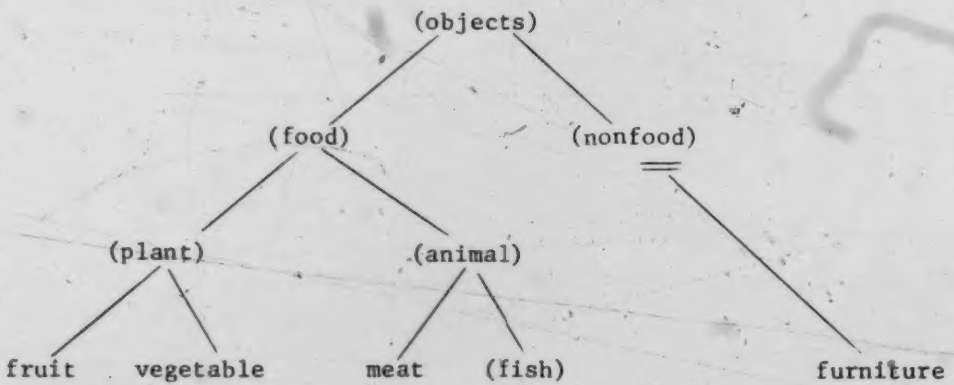
Proposed Research

The research of this thesis was undertaken primarily to investigate the nature of semantic encoding in children with particular interest focused on the automatic encoding of multiple features of meaning. The Wickens technique was selected for this research because it has several characteristics which permit exploration while avoiding the pitfalls of other methods. It controls for the subjects' use of rehearsal strategies, it allows for the investigation of multiple attribute shifts, it is appropriate for research with young children and it measures subjects' comprehension of categorizations rather than requiring subjects to produce the categorizing responses.

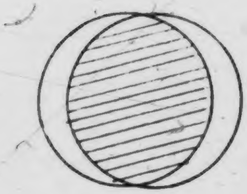
The design of the present study follows the procedure of Wickens and Eggemeier (in Wickens, 1973) and Wickens, Dalezman and Eggemeier (1976) which was described previously on page 20. Experimental subjects were presented with word triads drawn from one category for three trials and on the fourth trial were shifted to a triad drawn from a different category. Control subjects recalled words from the same category for all four trials. For both experimental and control subjects a distracting task was performed between the presentation of a triad and its recall.

In the present research, three subclasses of the food category (fruit, vegetable and meat) plus the furniture category were the concepts investigated. Experimental subjects recalled words drawn from one of the three classes of vegetables, meats or furniture for three trials; on Trial 4 these subjects recalled a triad drawn from the fruit category. Control subjects recalled triads from the fruit category for all four trials. Performance of all subjects was compared in Trial 4 where they were recalling the same material and differed only in their experimental histories.

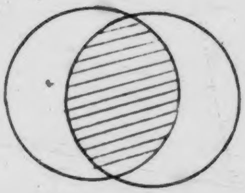
The superordinate category of foodstuffs was chosen as the dimension to investigate for two reasons: (1) Wickens has studied this variable with adults and the adult performance could be used as a comparison for the children's results. (2) Children are familiar with food categories and labels. It seemed more likely that children would have begun to classify food types in a hierarchical way rather than other such subcategories as types of professions or types of animals. Hierarchical ordering of features is an element of Clark's (1973) Feature Acquisition Hypothesis that gives rise to Clark's predictions about children's comprehension of word meaning. Clark's predictions are relevant for one set of hypotheses of this study and it was therefore important that the words presented to the children could be hierarchically ordered. The hierarchical interrelationships of the four categories of words pertinent to this thesis might be represented figuratively in the following way:



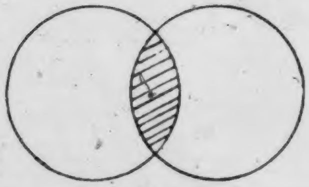
If the interrelationships of these categories are considered more from a feature point of view, one might depict them schematically as follows:



fruit-vegetable



fruit-meat



fruit-furniture

The areas of overlap represent shared features and the nonoverlapping areas represent differing features. If children demonstrate a sensitivity to these differences in feature overlap, then they must be processing groups or bundles of features at one time. By so doing, they will show themselves to be similar to adults in their semantic organization for these categories of words.

Background to Hypotheses

This investigation was not designed to verify the theory of one researcher or another, although results may be consistent with predictions flowing from a particular position. Rather, the thesis is concerned with documenting children's ability to encode multiple features and the research from related areas is reviewed so that knowledgeable predictions about children's performance may be made.

The review of Chapter II depicts two main trends in children's cognitive processing. One position emphasizes developmental differences in children's categorizing skills. The other position focuses on similarities in the cognitive abilities of younger and older children. Two sets of predictions about children's multiple encoding abilities follow from these two viewpoints.

Developmental Differences. The developmental literature depicting differences in cognitive abilities as a function of age is very large.

Some of this research has pointed fairly consistently to the age levels at which differences between groups of subjects are found. The ages of eight and eleven years are two levels which are frequently mentioned, with eleven-year-old children often found to be capable of "adult-like" behaviour. Anglin (1970) has found 11-year-olds to be more comparable to adults in the way they sort groups of words than are younger children aged 3 to 4 and 7 to 8 years. Mosher and Hornsby (in Bruner et al., 1967) have found 11-year-olds to be capable of forming hierarchically organized plans in a game of "Twenty Questions". Gibson and Gibson (in Klausmeier et al., 1974) have found 11-year-olds to be capable of adult discriminations of differences among scribbles. Younger children 6 to 8 years of ages did not reach criterion. Bruner (1964) has noted that a change to the symbolic mode of representation occurs around the age of twelve years. The symbolic stage is maintained throughout adulthood. Also, it is around the age of 11 years that children begin to show evidence of Piaget's formal operational thought. These are some of the justifications for deciding to begin the question of multiple encoding with grade 6 children. If there are developmental differences in encoding skills, the evidence seems to indicate that grade 6 children (11-year-olds) should be capable of the discriminations and organization necessary to show multiple encoding.

In an attempt to trace the course of the development of multiple encoding, a younger group of children was also tested. Certain changes in children's processing abilities have been noted to occur around the age of 8 years. Eight-year-olds seem more abstract and less concrete in their thinking than younger children (Anglin, 1970; Bruner et al., 1967); they appear to be in the early stages of developing hierarchical planning skills (Bruner et al., 1967) and they tend to be able to process two or more features of a perceptual display at one time (Klausmeier et al., 1974). Additionally, many 8-year-olds have reached Piaget's stage of concrete operational thought and are in a transition period between Bruner's (1964) ikonic and symbolic stages of thought. Because these developmental theories have noted specific differences occurring around the 8th to 9th year, it was decided that the second experiment would be conducted with children in grade 3. According to these findings eight-year-olds should show some ability for multiple encoding but less competence than the eleven-year-olds.

The investigations of Clark may shed some light on the possible differences in performance which may occur between 8- and 11-year-old children. Clark's (1973) Feature Acquisition Hypothesis suggests that children sometimes confuse words which overlap greatly in meaning. The three categories of words that are being compared with fruit items are vegetables, meats and furniture. There is obviously great overlap in meaning between fruits and vegetables. Actually, adult subjects show very small release when shifted from vegetables to fruits (Wickens et al., 1976). The suggestion that eight-year-old children may not differentiate fruits and vegetables is consistent with Clark's depiction of a hierarchical ordering in the acquisition of features, with features lower in the hierarchy acquired later. The features which differentiate fruits and vegetables may not have been acquired and therefore, the subjects would experience no shift in meaning when stimulus materials are changed from one category to the other.

Developmental Similarities. The developmental literature depicting similarities in the processing skills of adults and children is growing as researchers become more sensitive to the impact of the experimental task on children's ability to demonstrate competence. Rosch (1973) has evidence indicating that the internal organization of semantic categories is similar for adults and children for core or focal members. In this study only high frequency members of the four categories, as drawn from the Battig and Montague norms (1969), are used. The build up of PI is determined by common category membership and the release depends upon a final nonmember triad. Applying Rosch's theory and hypotheses to Wickens' technique, it is predicted that both age groups of children will encode multiple features and will demonstrate an understanding of the category overlap that is consistent with adult categorizations.

Huttenlocher (1974) has found children's comprehension of language to be in advance of their language production and has noted many similarities in the receptive language skills of adults and children. The Wickens task assesses comprehension of word meaning and it would be consistent with Huttenlocher's findings, for young children as well as older children and adults to be comprehending word meanings in a comparable manner.

As noted in Chapter II, children have consistently differed from adults in the strategies employed to recall information. Adults and older children apply very efficient organizing strategies. Younger children are capable of such strategies but do not apply them voluntarily. The Wickens task removes these differences between the skills of older and younger subjects by controlling the rehearsal strategies of the subjects. A rehearsal preventative task follows each presentation of a triad.

Also, some suggestions have been made (personal communications, Olson, D. and Wickens) that previous investigations of children's cognitive processing have underestimated the complexity of children's organizing skills. The PI release technique has found evidence of categorizing in children as young as three years of age, while traditional sorting tasks have found such organization to be evident much later. Wickens technique may be more sensitive to children's understanding of word meaning than other methods and as a result it may also be easier for children to give evidence of multiple encoding on a Wickens task.

The predictions which are consistent with theories emphasizing the importance of age and development are not formulated as a test of the validity of these theories. If the predicted differences are found, one type of information about children's encoding of features will be derived and support for a particular developmental theory (for example, Clark's, 1973) will also be offered. Similarly, the predictions based on the theories of Rosch and Huttenlocher are not designed to test the validity of their theories. However, if the findings are consistent with these predictions, they will not only illuminate children's encoding processes, but also will add some support to the theories of these researchers. In both cases, the goal of the research is to examine children's word encoding and to offer an explanation of how the obtained results might reflect on children's encoding of semantic features.

Hypothesis for Developmental Differences

Grade 6. Considering the theoretical positions of Anglin (1970), Bruner (1964) and Klausmeier et al. (1974) it seems reasonable to expect that grade 6 children are capable of hierarchical organization of information and have acquired all the salient hierarchical features necessary to differentiate the three cateogories of food words. It is predicted that grade 6 children will make fine discriminations in word meaning and will show PI release for both shifts in class (food-nonfood) and subclass (vegetable-fruit, meat-fruit).

More specifically, in agreement with Collen, Wickens and Daniele's (1975) analysis of the overlap in meaning of the four categories of words, it is predicted that the shift from furniture to fruit items will produce the greatest amount of PI release, the shift from meats to fruits, an intermediate amount of release, the shift from vegetables to fruits still less release and the no shift condition (fruits for four trials), no release. That is, not only are differences predicted between the three experimental and one control condition on the fourth trial, but also a particular ordering of the conditions is suggested that is consistent with the degree of meaning overlap between each of the experimental conditions and the control condition. The Trial 4 performance is predicted as follows: furniture > meat > vegetable > fruit (Fu > M > V > Fr).

Grade 3. Following Anglin (1970), Bruner (1964) and Klausmeier et al. (1974) it is predicted that grade 3 children will be in the initial stages of organizing information hierarchically and will encode more than single features of meaning at a time. However, consistent with Clark's (1973) theory, it is expected that grade 3 children will not have acquired the features necessary to differentiate the fruit and vegetable condition: the features differentiating fruits and vegetables would be situated in a relatively low position in a hierarchical organization of features relating to these words and Clark suggests that these features are acquired after more general features. It is expected that grade 3 children will show PI release when shifted from both meats and furniture to fruit. However, it is felt that the overlap between the fruit and vegetable categories requires too fine a discrimination for grade 3 children to show PI release. The ordering of conditions on

Trial 4 is predicted as follows: Fu >M >V = Fr.

Hypothesis for Developmental Similarities

Grade 6 and Grade 3. The predictions for the ordering of conditions on Trial 4 are the same for both age groups and will therefore be listed together. Based on the theories and findings of Rosch (1973) and Huttenlocher (1974) and the resulting careful selection of stimulus materials, it is predicted that children in both grades three and six will give evidence of multiple encoding of semantic features. Rosch suggests that the internal representations of categories are similar for adults and children if central members are presented. Therefore, not only are differences predicted between the three experimental and one control condition, but also the predicted ordering of conditions on Trial 4 is consistent with adult interpretations of the overlap in meaning of the four categories. On Trial 4, the following order is predicted: Fu >M >V >Fr.

Due to the complexity of the two sets of predictions, with differences expected between experimental and control conditions, as well as predicted orderings of the experimental conditions on Trial 4, descriptions of possible null hypotheses will be proposed in order to facilitate an interpretation of the results regardless of the final outcome. Three possible null hypotheses are suggested. If the results from the two grades fit the same description, support for a similarities account of children's semantic encoding will be obtained. If the results from the two grades fit the descriptions of two different hypotheses, support for a developmental differences position will be obtained. If the children's results correspond with any of the null hypotheses, support for a position advocating differences in semantic encoding between children and adults will be obtained. The following are the three null hypotheses:

1. The predictions of both the similarities and differences hypotheses have combined interpretations for multiple encoding with interpretations of "adult-like" comprehension of category membership. It is possible for multiple encoding to occur without coinciding with adult methods of categorization. For example, any ordering of experimental conditions on Trial 4, with significant differences between means, would indicate multiple encoding. One possible example is V > Fu > M > Fr. This ordering would support multiple encoding but nullify an "adult-like" comprehension of meaning overlap.

2. If significant differences between the three experimental and one control group were found, with no differences between the experimental groups (Fu = M = V > Fr), there would be no evidence to support multiple encoding. Single attribute shifts could account for all the PI release.

3. The most basic null hypothesis would predict no differences between the experimental and control groups. This outcome is highly unlikely because of the large semantic distance between fruit and furniture items. It would be more likely for subjects to be unaware of the within category shifts and still show PI release for the furniture shift: the ordering would be Fu > M = V = Fr. This ordering would indicate no multiple encoding and no differentiation within the food category.

In summary, the hypotheses predict not only significant differences between the experimental and control groups but also a particular ordering of conditions on Trial 4. It is the ordering of the conditions which will give the most information about the kinds of encoding employed by children.

Verbal Ability. One final variable was controlled in the study. In order to increase the power of the analysis and the meaningfulness of the results, the subjects were divided into two groups according to estimates of their level of verbal ability; subgroups were then compared. Hunt, Frost and Lunneborg (1973) and Hunt, Lunneborg and Lewis (1975) have found performance differences between high and low verbal ability adult subjects on short-term memory (STM) tasks. High verbal subjects are more rapid in recognizing particular visual patterns as words or letters and in manipulating data in short-term memory, than low verbal subjects. They also retain in STM more information about the order of item presentation.

Gamlin (1976) has investigated a similar variable with children. He has found differences in performance on tasks of language comprehension by children rated as belonging to the upper or lower academic half of their class. Children eight and ten years of age located in the lower half of their class preferred the abstract meaning of proverb sentences significantly less often than same-aged children from the top half of the class.

Because level of verbal ability has been found to influence performance on STM and language tasks, it was decided to observe the influence of this variable on encoding skills. If verbally proficient children are able to manipulate information in STM more rapidly than children of lower verbal ability, it is also possible that they have more time to encode features of meaning for each word.

Level of verbal ability was estimated in this thesis by performance on a vocabulary test. All subjects from each grade were rank ordered according to the vocabulary measure and then were divided into two groups per grade, one above and one below the median. Performance of high and low verbal subjects was compared.

CHAPTER IV

METHOD

Design

The design can be represented as follows:

Experimental Groups--Category Shifts

1. furniture to fruit
2. meat to fruit
3. vegetable to fruit

Control Group--Category Constant

4. fruit to fruit

Children in grade 6 and grade 3 served as subjects in the experiment. In both grades the children were divided into two groups according to level of verbal ability. (See Appendix A for description of vocabulary tests employed for this procedure.) From each verbal ability group, four subgroups were formed to make three experimental and one control group.

All subjects were tested individually and completed several practice trials before beginning the test trials. During formal testing, experimental subjects recalled words drawn from one of the three categories of vegetables, meats or furniture for the first three trials and words drawn from the fruit category for the fourth trial. Control subjects recalled fruit items for all four trials. After completing the fourth trial, subjects were presented with a sorting task. The fruit words plus the words from one of the three other categories were presented to the subjects in a random order; subjects were asked to sort the words into two groups. This sorting task marked the end of the experiment.

Subjects: Grade 6

One hundred and twenty-eight grade 6 boys and girls attending five elementary schools in Toronto were selected for the study. Language development has been said to be influenced by socioeconomic status (Bernstein, 1961; Bereiter, 1966; Ginsburg, 1972); therefore, an attempt was made to control, as much as possible, the similarity in socioeconomic background of the pupils taking part in the study. The school board participating in the study had previously rated all schools in its system according to their need for extra programmes and aids to assist students. The schools had been grouped into five levels from most to least needs (1 to 5 respectively). The children who participated in the first experiment attended schools belonging to the fifth quintile; that is, schools rated as having the least need for extra help. Basically, these schools served middle class, white collar areas. After choosing the schools, subject selection was based on the following criteria:

1. Written parental permission that the child be allowed to participate in the study (see Appendix F).

2. The child's year of birth be 1964. This required that the child had neither failed nor accelerated.

3. A grade 5 score be available for the child on the vocabulary subtest of the Canadian Test of Basic Skills. The Metropolitan Separate School Board systematically tests all pupils at certain grade levels and the most recent standardized testing for the grade 6 pupils occurred the previous year in grade 5.

4. English be spoken by the child as a first language.

In order to find 128 subjects meeting these criteria, over 300 children were processed. The final sample was made up of 73 girls and 55 boys.

Following selection, the 128 subjects were rank ordered according to their percentile scores on the vocabulary subtest of the Canadian Test of Basic Skills. These subjects were then divided into two groups, one above and one below the median. Scores of high performers ranged from 90% to 69% (mean = 76.45%, SD = 5.46%) and scores of low performers ranged from 68% to 48% (mean = 60.49%, SD = 5.44%). Each group of 64 subjects was then randomly divided into four subgroups of 16 subjects to form three experimental and one control group.

Subjects: Grade 3

One hundred and twenty-eight grade 3 boys and girls attending seven elementary schools in Toronto were selected for the study. As there were not sufficient grade 3 children available in the five schools of the grade 6 study, pupils from two additional schools were added to the sample. These two additional schools were chosen from the fifth quintile ranking described in the previous subject section. After choosing the schools, subject selection was based on the following criteria:

1. Written parental permission that the child be allowed to participate in the study.

2. The child's year of birth be 1967. This required that the child had neither failed nor accelerated.

3. A grade 2 score be available for the child on the vocabulary subtest of the Gates-MacGinitie Reading Test; the Metropolitan Separate School Board's most recent standardized testing for the grade 3 pupils occurred the previous year in grade 2.

4. English be spoken by the child as a first language. Bilinguals,

who spoke at home a language other than English were excluded in all but three cases.

In order to find 128 subjects meeting these criteria, over 300 children were processed. The final sample was composed of 76 girls and 52 boys.

Upon selection, the 128 subjects were rank ordered according to their percentile scores on the Gates-MacGinitie Reading Test. The subjects were then divided into two groups, one above and one below the median. Scores of high performers ranged from 99% to 75% (mean = 88.34%, SD = 7.57%) and scores of low performers ranged from 73% to 10% (mean = 49.31%, SD = 17.93%). Each set of 64 subjects was then randomly divided into four groups of 16 subjects to form the three experimental and one control group. (See Figure 1 for a bar graph distribution of reading scores of Grade 6 and Grade 3 subjects.)

Preparation of Word Lists

Twelve words from each of the categories of fruit, vegetables and furniture were selected from the Battig and Montague (1969) norms. These norms rank items, which are classified by category, according to the frequency with which the examples were listed by a large population of adult subjects as belonging to the category. An item's Battig and Montague ranking has been found to correlate highly with adults' estimates of the degree of categorical centrality of the item (Rosch, 1973); Rosch has found children's reaction time behavior to be similar to adult's when making categorical judgments about central category members. In the present research only examples which occurred within the first fourteen rank orderings for each category were used.

The Battig and Montague norms do not list items for the meat category. Norms were generated for the meat category by asking 31 children in a grade

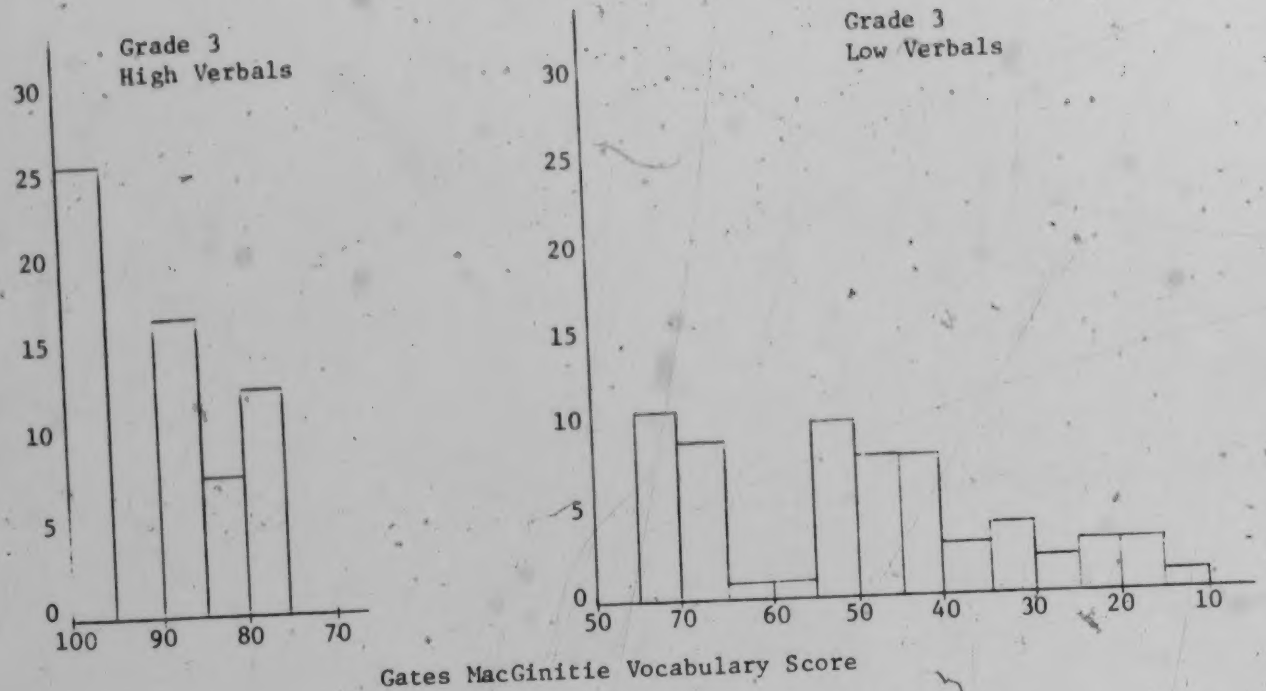


Figure 1. Bar graph distribution of reading scores by grade and verbal ability level.

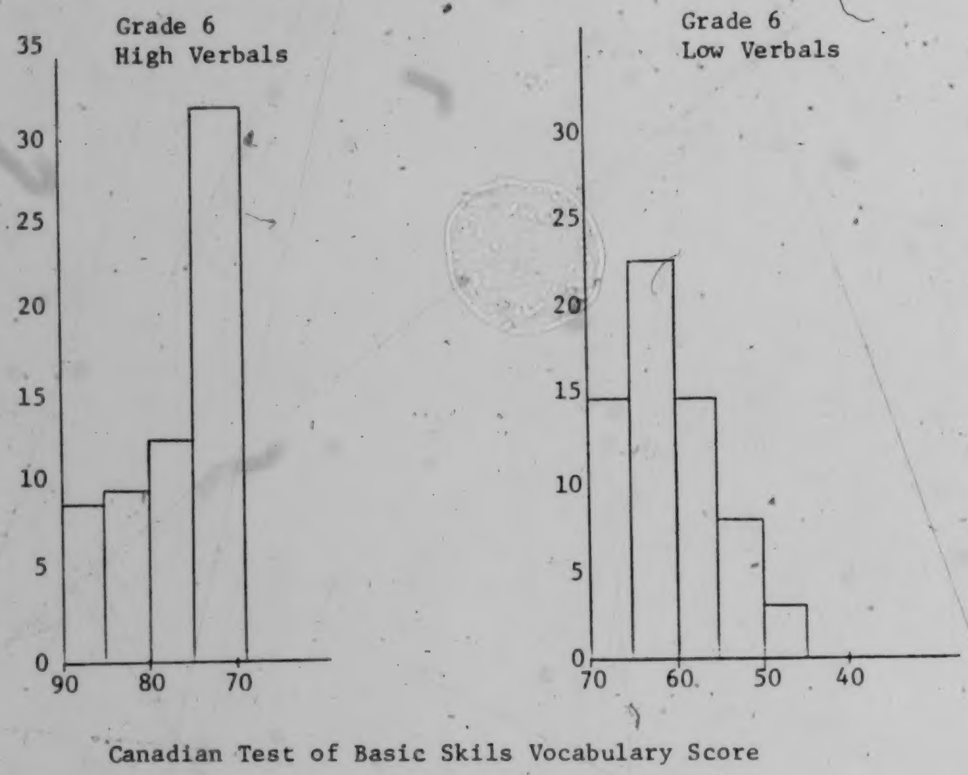


Figure 1.--Continued

5 and 6 class, 17 children in a grade 2 and 3 class and 17 children in a kindergarten class to generate meat names. This represents all the children registered in these grades in the particular school which participated in the pilot investigations. Children from the four older grades were tested in their classrooms and were asked to record on sheets of paper as many examples of meat names as they could generate. These children had no difficulty with the task. Kindergarten children were interviewed individually and were asked first to name as many meat items as they could. Usually these children named one to three items. They were then shown pictures of different meats and were asked to identify the pictures. Finally, they were read examples from the categories of nonalcoholic beverages, meats and vegetables and were asked to state whether the example belonged to the meat, vegetable or drink category. The ratings for the kindergarten children were mainly obtained by this third method. Rank orderings of the most frequently named meat items for the different age groups are included in Appendix B.

A number of normative studies were examined to determine which lexical items obtained high word frequency ratings. The word norms of Rinsland (1945), Buckingham and Dolch (1936) and Thorndike (1931, 1945) were consulted. See Appendix C for a description of these analyses.

After deciding upon the words to be used in the experiment, word triads were developed. When forming word triads for each category, attention was paid to equating mean word frequency and mean number of syllables across triads. The triads for each category, with their Battig and Montague rankings, their word frequencies and number of syllables are listed in Appendix D. The four triads representing each condition were: Fruit--banana, grape, apple; peach, apricot, orange;

pear, lemon, plum; grapefruit, cherry, lime; Vegetable--carrot, bean, lettuce; celery, corn, beets; potato, rice, cabbage; broccoli, peas, spinach; Meat--sausage, steak, chicken; ham, spareribs, bacon; roast, hot dog, pork; bologna, beef, turkey; Furniture--desk, couch, dresser; bed, sofa, stool; cabinet, chair, lamp; table, bookcase, rug.

The preparation of word lists followed the principle of the latin square in the ordering of triads. Four different word lists were composed for each condition. The following description presents the rules for list construction within each condition. Each list was made up of four triads. Each triad represented one trial. For the first three trial positions, each triad appeared equally often in each position, when all four lists per condition were considered. The trial four triads were fruit items for all conditions. The four fruit triads were counterbalanced across conditions, so that subjects in each condition heard each fruit triad equally often. The four triads per condition were labelled 1 to 4 and the ordering of triads within lists was as follows:

				Shift
Trial	1	2	3	4
List 1	1	2	3	4
List 2	4	1	2	3
List 3	3	4	1	2
List 4	2	3	4	1

Numbers refer to triads within conditions

From a perusal of the lists in the above notation, it can be seen that the same rules allowed for the formation of word lists for the three experimental and one control condition. These lists are referred to as blocks within condition in the results section. (See Appendix K for the word lists and practice items.)

The important points to retain about the composition of the word lists are:

1. Each triad appeared equally often in each trial position for the first three trials. Therefore, any differences between triads within conditions would not positively or negatively affect the outcome of the study because their effects would be counterbalanced across trial points.

2. On Trial Four all subjects recalled fruit items and the four fruit triads appeared equally often in each condition.

Preparation of Stimulus Materials

The instructions and stimulus materials were tape-recorded in a male voice in the recording studio of the Ontario Institute for Studies in Education. All information was first recorded onto an Ampex 440 tape recorder. This original recording was then electronically duplicated onto an Ampex 600 tape recorder. The Ampex 600 tape was then edited and dubbed onto seventeen tape cassettes (one practice tape and sixteen test tapes). The cassette tapes were played for the subjects via a Philips cassette recorder, model N2205. A splitter box was used to allow two sets of headphones to be attached simultaneously to the Philips recorder.

Apparatus

A quiet room with a desk or table and two chairs was required for the testing sessions. Both the subject and the experimenter listened to the taped information through earphones. An answer booklet was prepared for each subject in which the experimenter recorded the subject's practice and test responses as well as the sorting task data. (See Appendix E for a copy of the answer booklet.)

A sorting task was included in the study to control for the possibility that the children might not differentiate between the four conditions on the release trial. If the children were unable to encode the features during testing it was necessary to know if they could at least sort the categories, given overt instructions and no time limit. Three different sets of twenty-four index cards were prepared for the sorting tasks. Each set contained the twelve fruit items of the control condition plus the twelve experimental items from one of the experimental conditions. The words were printed on 3 by 5 inch index cards and each set of cards was shuffled and placed in an envelope.

Procedure

Teachers were asked to prepare a list of all pupils in their classes who spoke a language other than English at home. Names of subjects meeting the necessary requirements for participation in the study were entered onto a master list for each experiment; the subjects were then rank ordered according to their reading scores and divided at the median into a group of high and low performers. Subjects in each group were then randomly assigned to one of the four conditions (three experimental and one control condition).

The author and a research assistant conducted the testing. The research assistant worked two days a week and the author three days a week. Testing took one month. Both experimenters balanced their testing across conditions and schools. All instructions and materials were presented by tape recorder and the experimenter's main function was to record the subject's verbal answers. Most children seemed eager to take part in the project and found the tasks easy. All the children were told that the testing was not related to their school work and they were assured that their performance was not being evaluated for school purposes.

Each subject was tested individually for a period of 10 to 15 minutes. Information was presented auditorally and both the experimenter and the subject listened to the instructions and materials via headphones. The experimenter recorded the subject's verbal responses.

The children received a number of pretraining trials prior to data collection. Before commencing the training trials, the subjects first listened to detailed instructions about the training tasks. These instructions told the subjects that the experimenter was interested in how children remembered letters and repeated numbers. The trials were referred to as games and the performance that was required of the children was described in detail. After all questions were answered and the experimenter was quite sure that the subject knew what to do, the first training trial was run. If the subject had any difficulty with the procedure of the first trial, at the end of the trial the tape recorder was stopped and the instructions were reexplained. The exact instructions for the training and test trials appear in Appendix G.

The pretraining trials followed the same procedure as the test trials, except the children recalled letter trigrams instead of word triads. Each trial consisted of a letter trigram followed by an interpolated delay task and then recall. On each trial, the subject heard a series of three letters and was required to repeat each letter of the triad aloud as soon as he heard it. The subject was then distracted from rehearsing the letters by means of a shadowing task in which the subject heard and repeated aloud a random series of fourteen single digit numbers, presented at a rate of one per second. At the end of the delay interval, the subject attempted to recall the letter trigram and then prepared for the next trial.

A tone indicated the immediate presentation of a letter trigram. The three letters were then presented during a 6 second period (2 seconds per letter) and were followed by a 14 second retention interval and then another tone signalling a 10 second recall interval.

A minimum of three and a maximum of five training trials were administered to all subjects. Any child unable to follow the procedure after five trials was dropped from the experiment. Three children did not continue because they were unable to perform the task properly.

The practice trials used letter trigrams as stimuli so that there would be no carry over of proactive inhibition from the practice to the test trials. Using the Wickens technique, words and letters have been found to be separate encoding categories for both children and adults. Additionally, subjects were given a minimum of a two minute rest period between practice and test trials. Loess and Waugh (1967) have shown PI to dissipate within two minutes.

After completing the training trials and the two minute rest period, the instructions for the test trials were presented. These instructions were very similar to the pretraining instructions, except that a new game was described involving words and numbers. After the subject had indicated that he did understand the instructions, the test trials were run without a break. Any subject erring in procedure during the test trials was eliminated from the study.

The procedure for the experimental trials was structurally identical to the procedure of the practice trials; the two tasks differed only in content. The experimental session consisted of four trials of word triads. For the experimental subjects, after three trials of words drawn from one category, a trial of fruit items was presented. The control subjects received fruit items for all four trials.

After each child had completed the test trials, a sorting task was administered. Each experimental subject was presented with a shuffled set of cards on which were printed the names of all the stimulus items, belonging to the two categories that he heard during testing. That is, subjects in the vegetable condition received 24 cards, 12 vegetable and 12 fruits; subjects in the meat condition sorted 12 meats and 12 fruits; subjects in the furniture condition sorted 12 furniture items and 12 fruits. The control subjects (in the fruit condition) who heard only fruit items for all four trials, were also asked to sort categories of words. One-third of these subjects sorted furniture and fruit items, one-third meat and fruit items and one-third vegetable and fruit items.

The following was the procedure for the sorting task. First the subject was asked to read aloud the words on the cards. If he had any difficulty doing so, the experimenter read the word for him. The subject was then told that there were two types of words on the cards and was asked to make two piles so that each pile contained only words of one type. After the sorting was completed the subject was asked to state the two categories into which he had sorted cards. If the subject failed to sort or sorted incorrectly, the appropriate category names were given and the subject was then asked to sort the cards on the basis of these categories.

After the sorting task was completed the subject was asked not to tell his classmates about the study until all the children had been seen.

CHAPTER V

RESULTS

Each subject received a score for each trial based on the number of words correctly recalled, one point for each word. One extra point was given if all three words were recalled in the correct order. This gave a range of scores from 0 to 4.[3] Analyses of variance were computed on these data, with subsequent Tukey tests applied to test the significance of differences between means. The significance criterion for all Tukey tests was $\alpha = .05$.

The results of the grade 6 and grade 3 groups are presented concurrently as many of the analyses were computed on the overall data with grade introduced as one of the factors. Basically, three different analyses of variance were calculated and appear in the following order in the presentation of the results:

1. The Trial Four data was analyzed to examine the significance of the PI release.

2. The first three trials were subjected to a repeated measures analysis of variance to test for PI build-up.

3. All four trials were subjected to a repeated measures analysis of variance to test for the overall significance of the subject factors

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[3] The data were also analyzed without giving an extra point for recall of the three words per triad in the correct order. Scoring out of three produced no significant differences in the results. These analyses are presented in Appendices H and I.

of grade and level of verbal ability. This analysis is really of secondary importance, overlapping with both the analysis for PI build-up and PI release. Because blocks were nested within condition on the first three trials and crossed with condition on the fourth trial, the repeated measures analysis over four trials was not employed to investigate PI build-up or release. However it does measure the overall effects of grade and verbal ability across all four trials.

Release from PI

Two alternative hypotheses were proposed for the Trial 4 data. The developmental differences hypothesis predicted the following ordering of conditions on Trial 4:

Grade 6: Fu > M > V > Fr.

Grade 3: Fu > M > V = Fr.

The developmental similarities hypothesis predicted a different ordering of Trial 4 conditions:

Grade 6: Fu > M > V > Fr.

Grade 3: Fu > M > V > Fr.

The two hypotheses differ in their predictions for the grade 3 groups, with the differences hypothesis not predicting grade 3 children to differentiate between fruit and vegetable items and with the similarities hypothesis predicting grade 3 children to make this distinction.

To test these two hypotheses, a four factor (2 grades, 2 verbal abilities, 4 conditions, 4 blocks) analysis of variance was computed on the Trial 4 data to assess PI release. Table 1 presents the results of this analysis. The analysis showed a significant condition effect: $F(3, 192) = 19.35$, $p < .001$ with no grade by condition interaction. From Table 2 it can be seen that Tukey tests found the means of each of the three experimental conditions to be significantly greater than the

Table 1. Results of the Analysis of Variance for the Trial 4 data.

Factors	df	Mean Square	F	Significance
Grade	1	26.91	21.42	p<.001
Verbal Ability (VA)	1	6.57	5.23	p<.02
Condition	3	24.32	19.35	p<.001
Block	3	9.39	7.47	p<.001
Grade x VA	1	1.13	0.90	ns
Grade x Condition	3	0.23	0.19	ns
VA x Condition	3	1.06	0.84	ns
Grade x Block	3	0.76	0.61	ns
VA x Block	3	0.34	0.27	ns
Condition x Block	9	0.63	0.50	ns
Grade x VA x Condition	3	0.37	0.29	ns
Grade x VA x Block	3	0.19	0.15	ns
Grade x Condition x Block	9	1.13	0.90	ns
VA x Condition x Block	9	0.87	0.69	ns
Grade x VA x Condition x Block	9	0.86	0.69	ns
Ss/Grade x VA x Condition x Block	192	1.26		

Table 2. Tukey Test Values for Differences between Condition Means for Trial 4 data.

Condition	Mean	Furniture 2.95	Meat 2.67	Vegetable 2.30	Fruit 1.53
Furniture	2.95		0.28	0.65*	1.42*
Meat	2.67			0.37	1.14*
Vegetable	2.30				0.77*

Significant difference at .05 level = 0.51

mean of the control condition. In addition, the furniture mean was significantly greater than the vegetable mean. In sum, furniture > vegetable > fruit, with meat midway between furniture and vegetable and not significantly different from either. These Trial 4 results support the similarities hypothesis, as children in both grades showed significant PI release for the vegetable to fruit shift; in addition, the overall ordering of conditions on Trial 4 coincided with the predicted ordering of the similarities hypothesis. Figure 2 presents these results.

Wickens has devised a formula, termed percent PI release, which facilitates the comparison of PI release results obtained from different experiments. This formula might also be useful for verifying the relative amounts of PI release obtained in the present study, in light of differences between the four conditions in PI build-up which are discussed shortly. Wickens' formula is: $\%\ \text{PI release} = \left(\frac{X}{Y}\right) 100$

where X = the difference between the experimental and the control group on Trial 4 (E - C),

and Y = the total decline of the control group (Trial 1 - Trial 4).

According to Wickens (1972), approximately 20% PI release is needed to reach the .05 level of significance. Using this formula, all experimental conditions demonstrated significant percent PI release. The ranking of the four categories was identical to the ordering indicated by Tukey Tests, for all groups and subgroups of subjects, that is: Fu > M > V > Fr, (see Table 3). The percent PI release analysis, which compares the release obtained on the fourth trial to the overall decline of the control group, supports the results of the analysis of variance of the Trial 4 data, which does not consider responses on the first three trials.

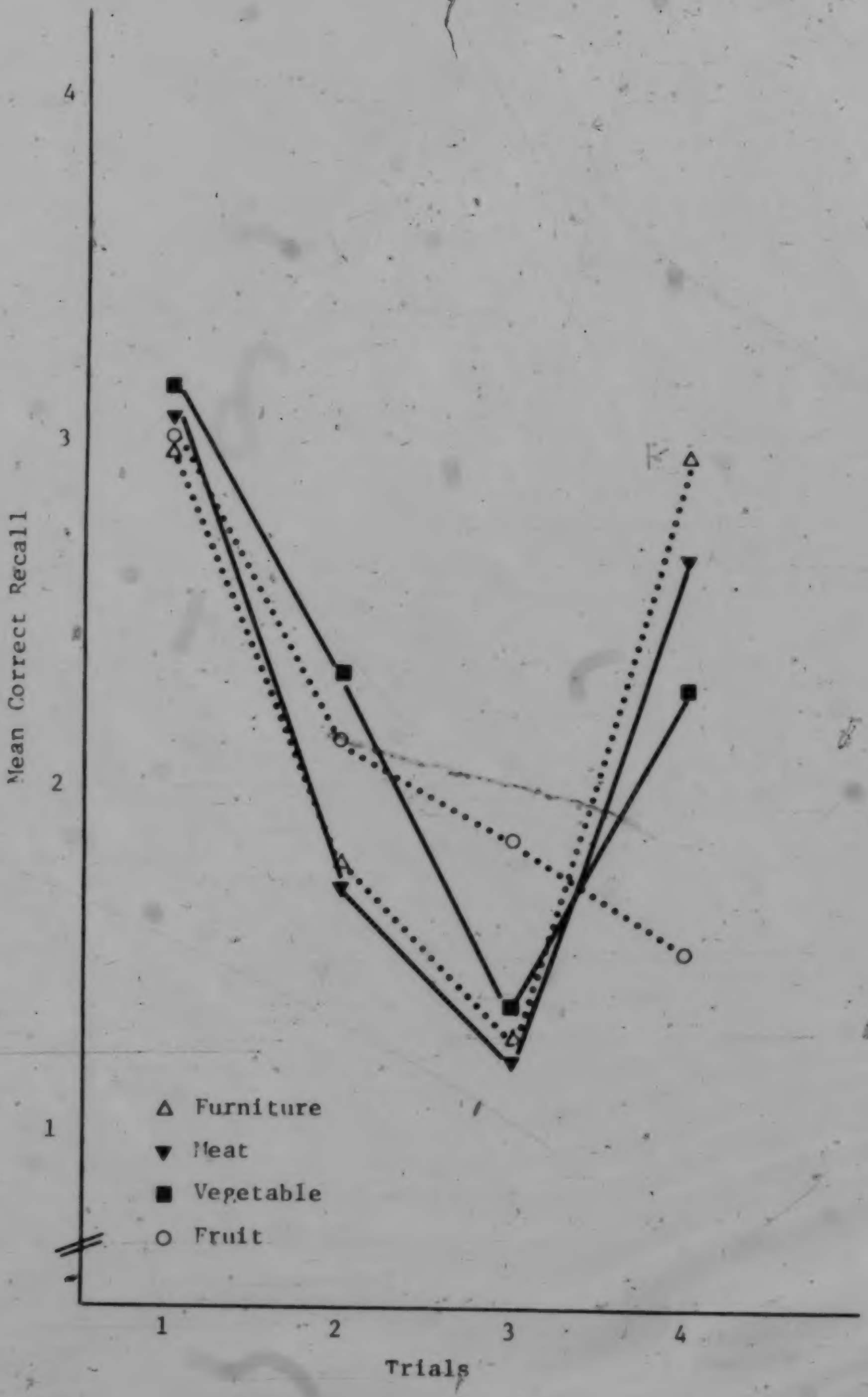

Figure 2. Mean correct recall for all subjects as a function of condition and trial.

Table 3. Per cent PI Release for Both Grades and Levels of Verbal Ability.

GRADE 6

	High Verbal Ss	Low Verbal Ss	All Ss
Furniture	83.33%	91.32%	86.79%
Meat	63.32%	60.87%	62.27%
Vegetable	46.66%	47.82%	47.17%

GRADE 3

	High Verbal Ss	Low Verbal Ss	All Ss
Furniture	116.00%	94.13%	107.13%
Meat	100.00%	88.25%	95.25%
Vegetable	75.99%	29.41%	57.15%

The ordering of conditions on the fourth trial was identical to the ordering predicted in the similarities hypothesis. On the basis of chance factors alone, there were twenty-four possible orderings of conditions on Trial 4; the correct prediction of one is significant at the .04 level. The prediction of the differences hypothesis that grade 3 children would show a different pattern of Trial 4 responses from grade 6 children was not supported. There was no interaction of grade by condition, indicating that the relative recall of conditions on Trial 4 was similar for the grade 3 and the grade 6 groups. The results of the analysis of the Trial 4 data support the similarities hypothesis and not the differences hypothesis.

PI Build-Up

Trials. Central to the Wickens technique is the build-up of PI over the first three trials. As shown in Figure 2, recall declined steadily across the first three trials. To test the significance of this effect, a repeated measures analysis of variance was computed over Trials 1 to 3. This was a five factor analysis with four between subjects variables (grade, verbal ability, condition, block) and one within subjects variable (trials). From Table 4 it can be seen that the trials effect was very significant: $F\ (2, 384) = 181.81$, $p < .001$. Tukey tests found the means of Trials 1, 2 and 3 to differ significantly, that is: Trial 1 > Trial 2 > Trial 3 (see Table 5 for Tukey results).

Grade. A significant grade by trial interaction suggested that PI build-up differed for the two grades: $F\ (2, 384) = 4.06$, $p < .025$ (Table 4). This interaction is depicted in Figure 3. As measured by Tukey tests (see Table 5) both grades showed a significant trials effect with the means of Trial 1 > Trial 2 > Trial 3. Also, grade 6 children were significantly higher than grade 3 children at all trial points. The

Table 4. Results of the Repeated Measures Analysis of Variance across the First Three Trials.

Factors	df	Mean Square	F	Significance
Grade	1	127.56	121.71	p<.001
Verbal Ability (VA)	1	20.35	19.41	p<.001
Condition	3	4.85	4.62	p<.005
Block/Condition (B/C)	12	1.21	1.16	ns
Grade x VA	1	0.22	0.21	ns
Grade x Condition	3	0.97	0.93	ns
VA x Condition	3	0.88	0.84	ns
Grade x B/C	12	1.24	1.18	ns
VA x B/C	12	1.50	1.43	ns
Grade x VA x Condition	3	0.85	0.81	ns
Grade x VA x B/C	12	0.69	0.66	ns
Ss/Grade x VA x Condition x Block	192	1.05		
Trial	2	162.81	181.81	p<.001
Grade x Trial	2	3.63	4.06	p<.025
VA x Trial	2	0.92	1.02	ns
Condition x Trial	6	2.69	3.00	p<.01
Block x Trial/Condition	24	1.46	1.64	p<.05
Grade x VA x Trial	2	0.80	0.89	ns
Grade x Condition x Trial	6	0.40	0.44	ns
VA x Condition x Trial	6	0.60	0.67	ns
Grade x Block x Trial/Condition	24	0.83	0.93	ns
VA x Block x Trial/Condition	24	1.97	2.20	p<.001
Grade x VA x Condition x Trial	6	0.35	0.39	ns
Grade x VA x Block x Trial/Condition	24	1.05	1.17	ns
Ss x Trials/Grade x VA x Condition x Block	384	0.90		

Table 5. Tukey Test Values for Differences between Trial Means for Grades 6 and 3, analyzed separately and in combination.

GRADE 6

Trials		1	2	3
	Mean	3.46	2.52	1.78
1	3.46		0.94*	1.68*
2	2.52			0.74*

Significant difference at .05 level = 0.28.

GRADE 3

Trials		1	2	3
	Mean	2.65	1.47	1.20
1	2.65		1.18*	1.45*
2	1.47			0.27*

Significant difference at .05 level = 0.27.

GRADE 6 AND GRADE 3

Trials		1	2	3
	Mean	3.05	2.00	1.49
1	3.05		1.05*	1.56*
2	2.00			0.51*

Significant difference at .05 level = 0.20.

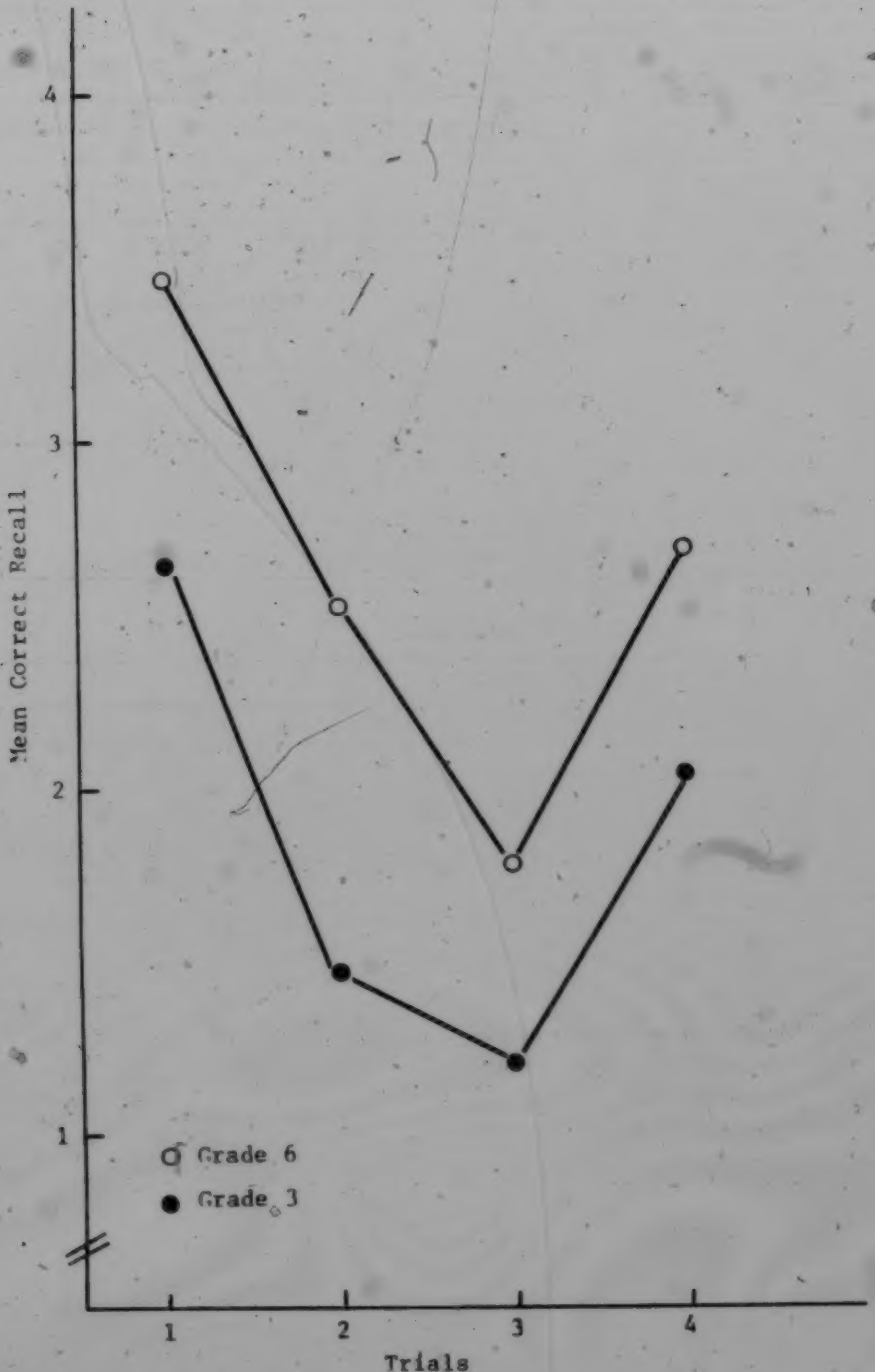

Figure 3. Mean correct recall as a function of grade and trial.

slopes of the lines depicting PI build-up for the first three trials seemed to differ for the two groups, with grade 6 children exhibiting a linear trend and grade 3 children a curvilinear trend. Proactive inhibition appears to have built-up more quickly for the grade 3 children. This finding is similar to the results of Pender (1969) regarding differences in PI build-up for two different age groups: her younger subjects showed greater PI build-up than her older subjects. The differences found in the present study were not as dramatic as Pender's and do not affect the interpretation of the main findings as children in both grades showed significant PI build-up and release.

Condition. Condition was found to be a significant factor on the repeated measures analysis of variance of the first three trials: $F(3, 192) = 4.62$, $p < .01$. When Tukey tests were applied, none of these differences in recall were found to be significant across the four conditions. There appeared to be a tendency for fruit and vegetable items to be recalled better than furniture and meat items.

The four conditions also differed in their PI build-up as indicated by a significant condition by trial (CT) interaction: $F(6, 384) = 3.00$, $p < .01$. This interaction is illustrated in Figure 2. Tukey tests found word recall to drop off significantly from Trial 1 to Trial 2 and from Trial 1 to Trial 3 for all conditions. In addition, the furniture and vegetable conditions showed a significant decline between Trials 2 and 3. Table 6 presents these Tukey test results.

In order to examine any systematic trends in the condition by trial (CT) interaction occurring over the first three trials, a trend analysis was calculated. When the sums of squares of the condition by trial interaction were partitioned into the linear and the quadratic components, the F

Table 6. Tukey Test Values for Differences between Means Within Conditions for Trials 1 and 2, Trials 1 and 3 and Trials 2 and 3.

		Trial 1			
		Furn	Meat	Veg	Fruit
	Mean	2.97	3.08	3.17	3.02
Trial 2					
Furn	1.78	1.19*			
Meat	1.72		1.36*		
Veg	2.34			0.83*	
Fruit	2.14				0.88*

Significant difference at .05 level = 0.39.

		Trial 1			
		Furn	Meat	Veg	Fruit
	Mean	2.97	3.08	3.17	3.02
Trial 3					
Furn	1.28	1.69*			
Meat	1.45		1.63*		
Veg	1.38			1.79*	
Fruit	1.86				1.16*

Significant difference at .05 level = 0.39.

		Trial 2			
		Furn	Meat	Veg	Fruit
	Mean	1.78	1.72	2.34	2.14
Trial 3					
Furn	1.28	0.50*			
Meat	1.45		0.27		
Veg	1.38			0.96*	
Fruit	1.86				0.28

Significant difference at .05 level = 0.39.

ratio for the linear effect was found to be significant: F (3, 384) = 5.68, $p < .001$, while the quadratic component was not significant. The CT interaction could be accounted for by the differences in the linear component of the trials effect across conditions. By inspection of Figure 2, it appears that the fruit condition showed less overall PI build-up than the other three categories.

In summary, while there were some differences in PI build-up for the four conditions, with a tendency for fruit items to be better recalled than the other three categories of words, all four conditions did show significant PI build-up over the first three trials. In addition the three experimental conditions showed significant PI release on Trial 4. The ordering of conditions on Trial 4 was consistent with predictions using the similarities hypothesis, with both the grade 6 and grade 3 groups responding in a manner consistent with multiple encoding theory.

Developmental Differences

In light of the research showing differences in memory capacity as a function of increasing age, the overall effects of the variables of grade and level of verbal ability were studied.

Grade. As shown in Table 1, there was no interaction of condition by grade on Trial 4, indicating that the patterns of PI release did not differ for the grade 6 and grade 3 children. However, grade was a significant factor: F (1, 192) = 21.42, $p < .001$. As indicated in Figure 3, grade 6 children recalled more words than grade 3 children on Trial 4. Table 7 presents the results from a repeated measure analysis of variance computed over 4 trials. This latter analysis indicates that the superior recall of the grade 6 children was consistent across the four trials: F (1, 192) = 118.69, $p < .001$. Grade level affected how

Table 7. Results of the Repeated Measures Analysis of Variance across All Four Trials

Factors	df	Mean Square	F	Significance
Grade	1	153.14	118.69	$p<.001$
Verbal Ability (VA)	1	29.91	20.86	$p<.001$
Condition	3	1.10	0.85	ns
Block/Condition (B/C)	12	2.10	1.63	ns
Grade x VA	1	0.88	0.68	ns
Grade x Condition	3	0.80	0.62	ns
VA x Condition	3	0.81	0.62	ns
Grade x B/C	12	1.57	1.21	ns
VA x B/C	12	1.44	1.12	ns
Grade x VA x Condition	3	0.97	0.75	ns
Grade x VA x B/C	12	1.12	0.87	ns
Ss/Grade x VA x Condition x Block	192	1.29		
Trial	3	110.67	118.36	$p<.001$
Grade x Trial	3	2.87	3.07	$p<.05$
VA x Trial	3	0.61	0.65	ns
Condition x Trial	9	11.15	11.92	$p<.001$
Block x Trial/Condition	36	1.62	1.73	$p<.01$
Grade x VA x Trial	3	0.69	0.74	ns
Grade x Condition x Trial	9	0.40	0.43	ns
VA x Condition x Trial	9	0.77	0.83	ns
Grade x Block x Trial/Condition	36	0.79	0.85	ns
VA x Block x Trial/Condition	36	1.58	1.69	$p<.01$
Grade x VA x Condition x Trial	9	0.31	0.34	ns
Grade x VA x Block x Trial/Condition	36	0.79	0.84	ns
Ss x Trials/Grade x VA x Condition x Block	576	0.93		

much information was recalled but not the relative recall of the four conditions on Trial 4.

Verbal Ability. As shown in Figure 4, high verbal subjects recalled more information than low verbal subjects: F (1, 192) = 20.86, $p < .001$ (Table 7). There was no interaction of grade, verbal ability and condition on either the Trial 4 analysis of variance (Table 1) or the repeated measures analysis over four trials (Table 7). However, the recall across all four trials, as organized by grade, level of verbal ability and condition is illustrated in Figures 5, 6, 7 and 8 in order to present a figural breakdown of the data according to subject group. While these figures depict the same significant condition by trial interaction, they also offer a display of the data which is not offered in Figures 2, 3 or 4. Figure 2 does not illustrate the significant effect of grade or verbal ability and Figures 3 and 4 do not depict the significant effect of condition or the condition by trial interaction. Figures 5, 6, 7 and 8 depict these effects in combination, thus removing the necessity of mentally synthesizing Figures 2, 3 and 4. In addition, Figures 5, 6, 7 and 8 offer a visual display of the data which parallels the design of the thesis.

As discussed earlier, there were differences in PI build-up for the two grades. These differences are particularly obvious when one compares the low verbal grade 3 group (Figure 8) and the two grade 6 groups (Figures 5 and 6). The differences between the four groups of subjects in overall recall seem quite systematic, with the following ordering of groups of subjects exhibited: grade 6 high verbal > grade 6 low verbal > grade 3 high verbal > grade 3 low verbal. While there were differences in overall recall, the ordering of conditions on Trial 4 was the same

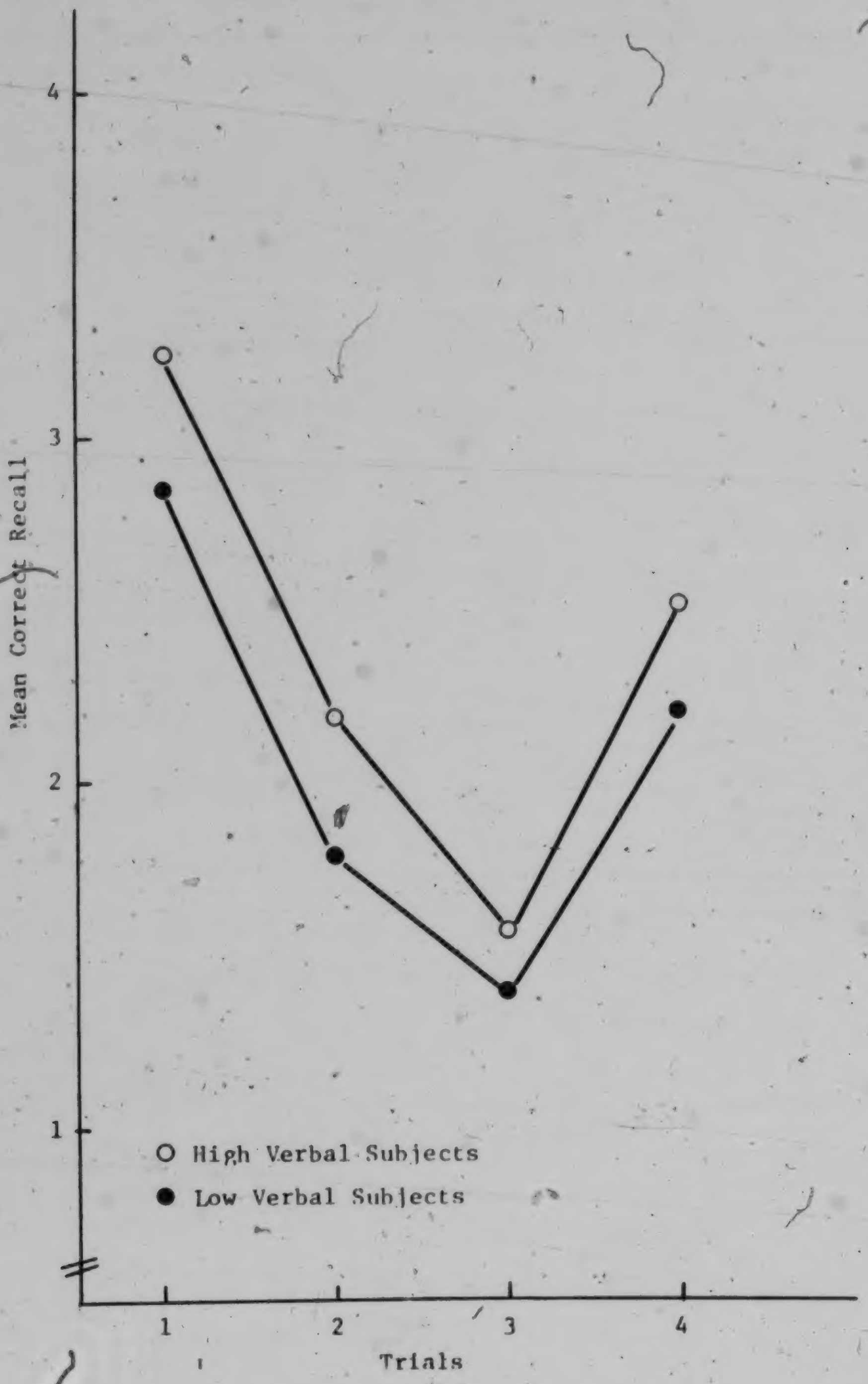

Figure 4. Mean correct recall as a function of verbal ability and trial.

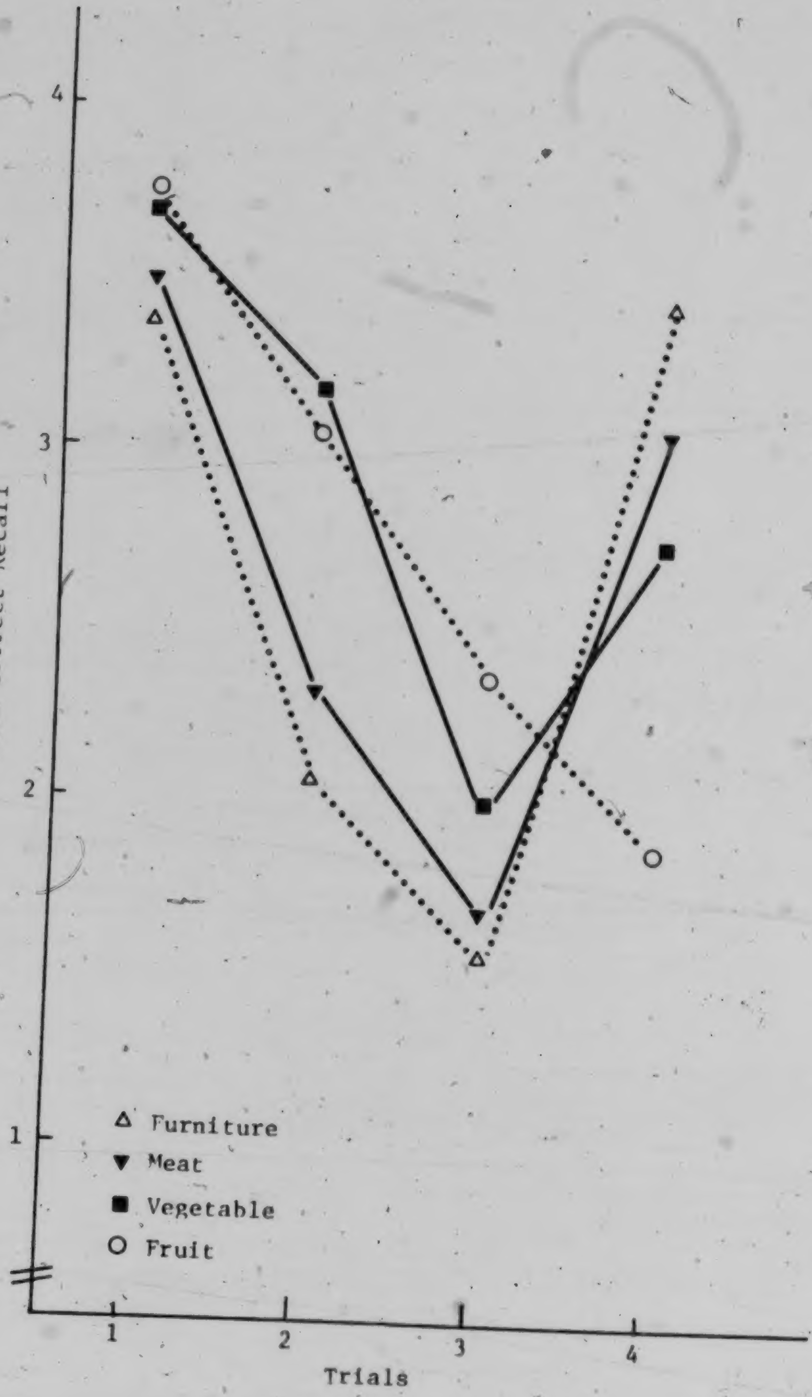

Figure 5. Mean correct recall of the Grade 6 High Verbal group as a function of condition and trial,

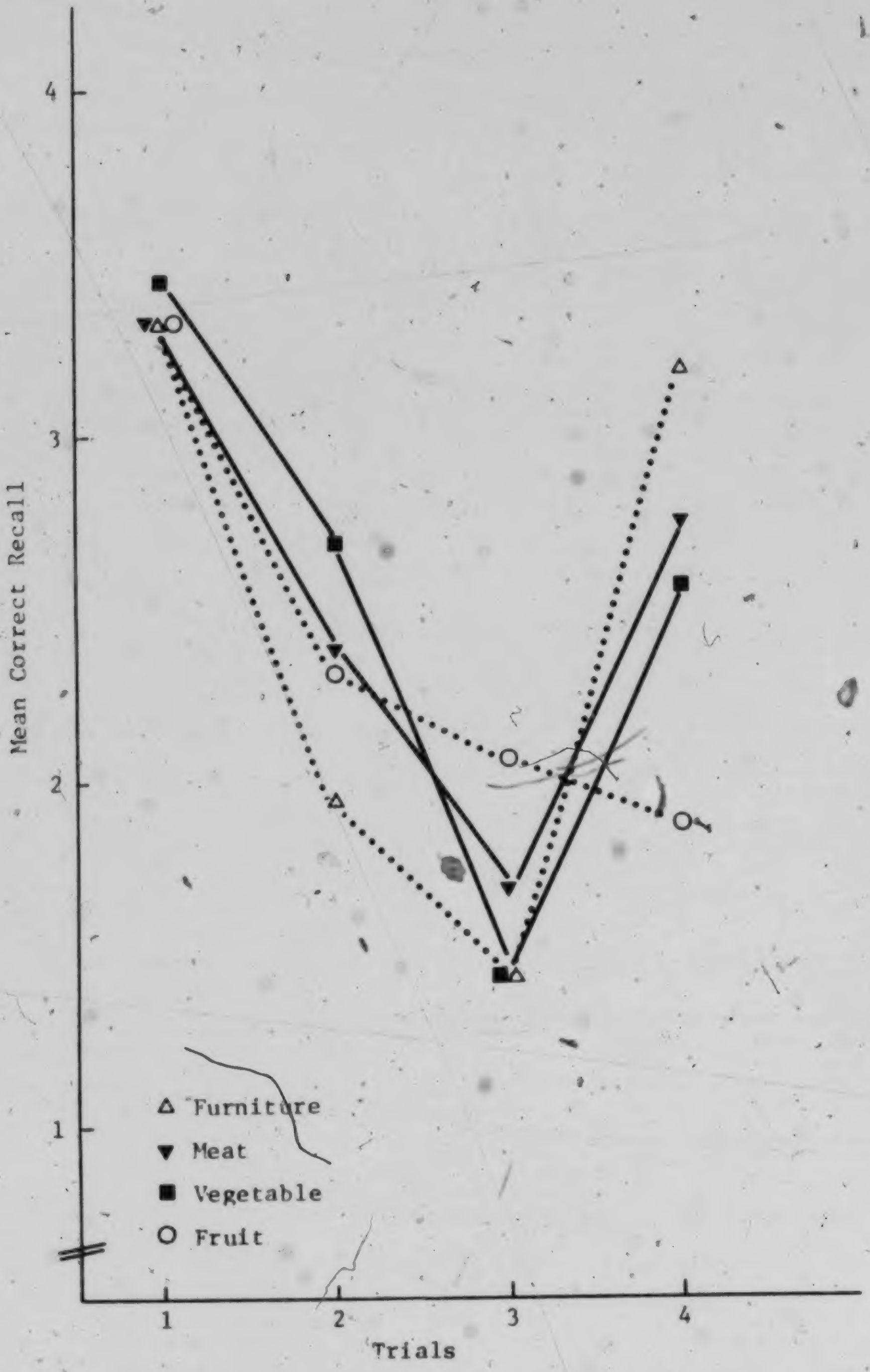

Figure 6. Mean correct recall of the Grade 6 Low Verbal group as a function of condition and trial.

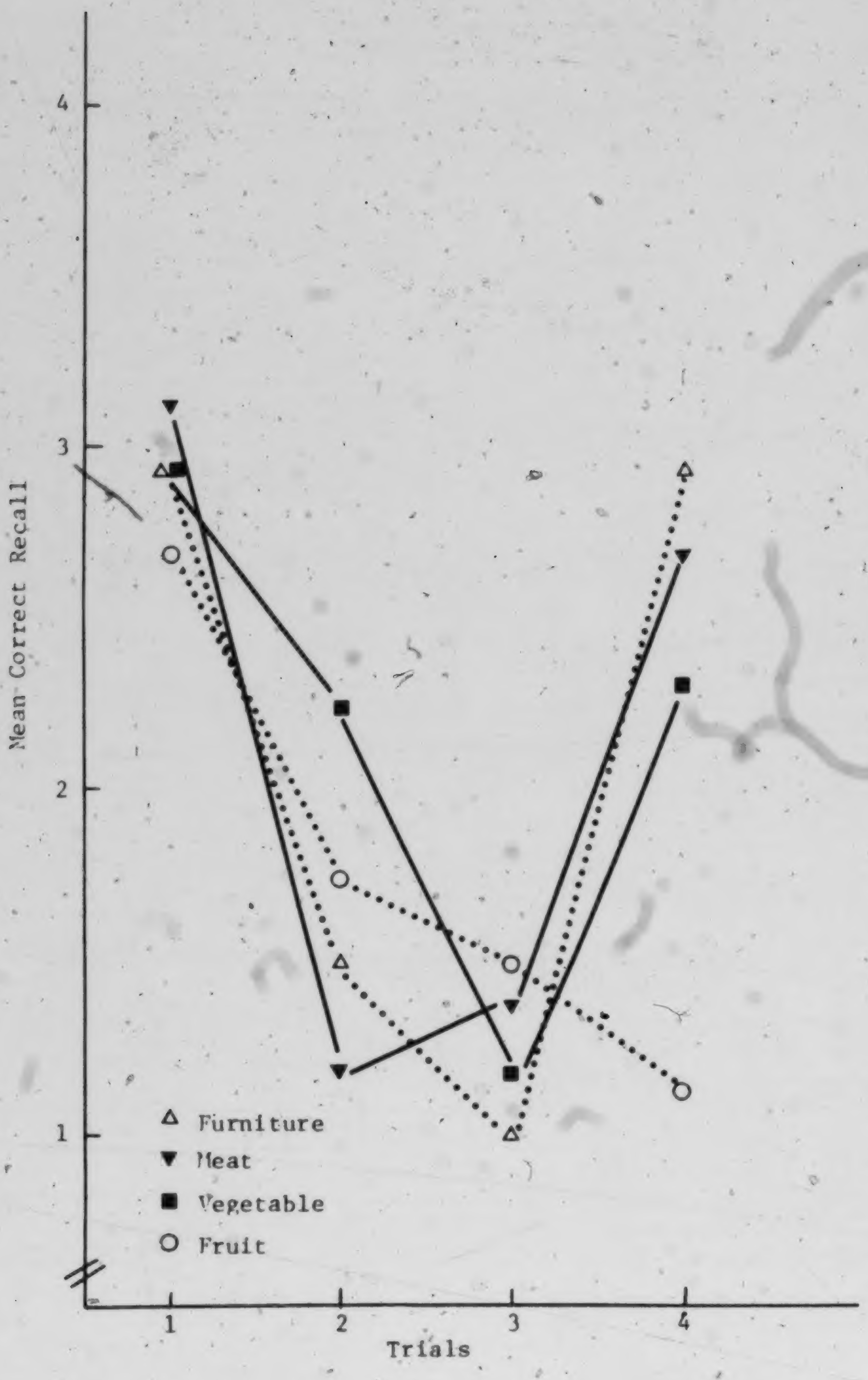

Figure 7. Mean correct recall of the Grade 3 High Verbal group as a function of condition and trial.

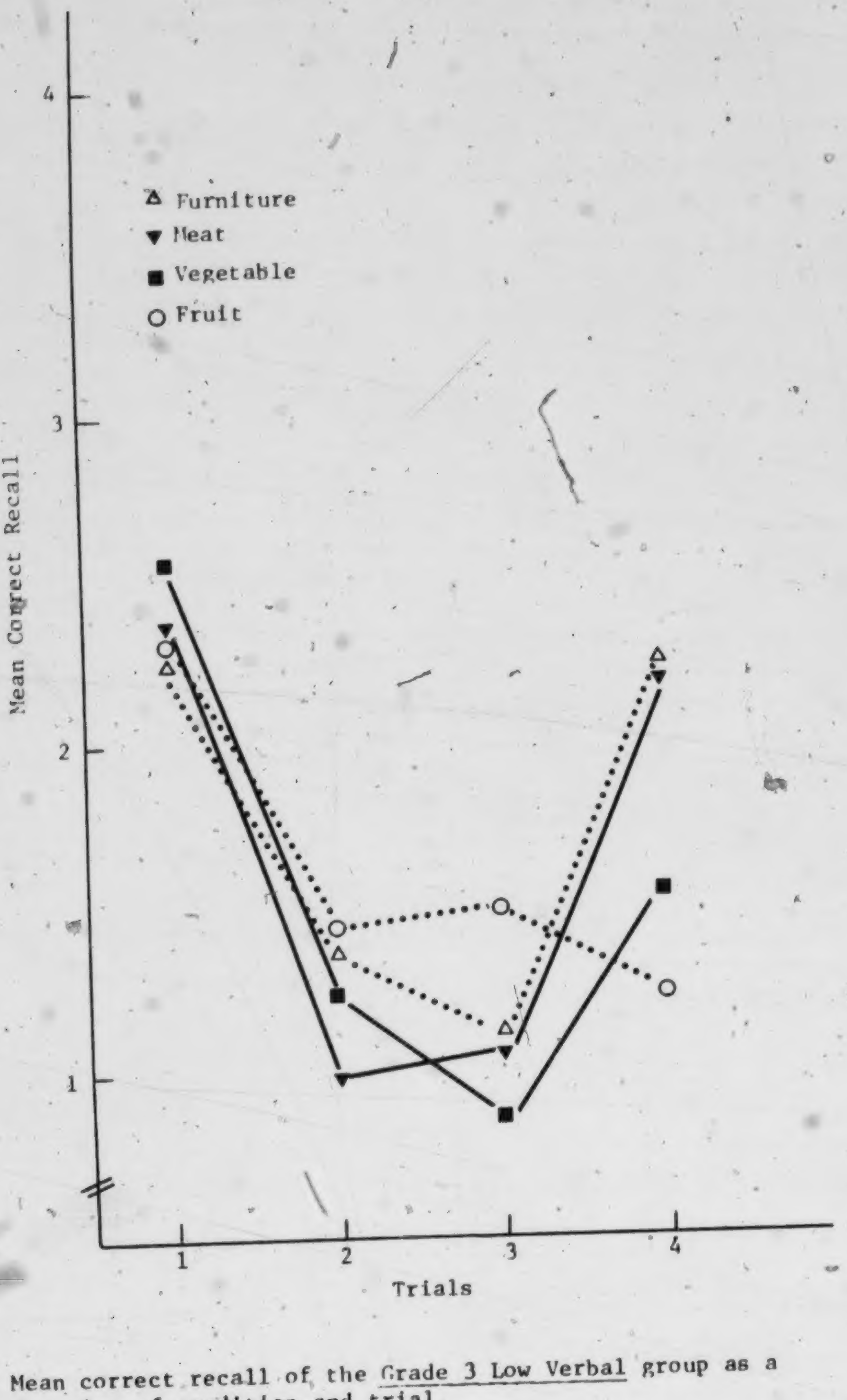

Figure 8. Mean correct recall of the Grade 3 Low Verbal group as a function of condition and trial.

for all groups of subjects. Level of verbal ability influenced the number of words recalled, but not the relative recall of the four conditions on Trial 4.

Analysis of Types of Errors

The type of errors occurring on the recall task might offer some insight into the operation of the PI effect. Subjects' errors were divided into three types. Omissions were scored when subjects recalled fewer than three words and incorrect responses were scored as substitutions of a new word or interferences of an old word. Omissions occurred most frequently. Out of a total of 1,057 errors, 783 or 74% were omissions; one hundred and fifty-seven or 15% were interfering items and 117 or 11% were substitutions. Children tended to omit items, rather than to give an incorrect response. This finding is consistent with Dillon's (1975) suggestion that proactive inhibition interferes with response generation rather than response selection and that subjects recognize an incorrect response. Rather than respond incorrectly they tended to give no response. (Refer to Appendix J for a breakdown of errors by trial, grade and verbal ability.)

Sorting Task

It will be recalled that the sorting task required subjects to read aloud the twelve words of two categories printed on cards and then to divide the cards into two piles. Although most subjects performed a perfect sort, some subjects made one or two errors and were still credited with a satisfactory sort. For both grades 3 and 6, 96.88% or 124 of the 128 subjects per grade, were able to read and sort the cards, either with or without the experimenter labelling the two categories for them. The eight subjects who were not credited with a correct sort made three or more errors in the category placement of the vegetable and fruit items.

Differences in sorting ability between the two grades were evident. As seen in Table 8, 91.4% of the grade 6 children were able to read and sort the cards without experimenter labelling, while only 75.0% of the grade 3 children could do so. For grade 6 subjects, an additional 5.47% sorted when the experimenter provided the labels, while 21.88% of the grade 3's gained from experimenter labelling. Table 8 also shows the breakdown of subjects by verbal ability and sorting levels. The important information noted in this table is that 248 of the 256 subjects were able to sort the words correctly into two categories.

The acceptable sorting errors made by grade 3 and grade 6 children will now be considered. It will be recalled that subjects were allowed two errors on the sorting task. Of the 20 grade 3's making 1 or 2 errors on the sorting task, 60% of the subjects made errors on the vegetable and fruit sorts, 20% made errors on the meat and fruit sorts and 20% erred on the furniture and fruit sorts. The six grade 6 children making acceptable sorting errors confused only vegetable and fruit items.

Nearly all subjects were able to sort the groups of words into their appropriate categories. The eight children who made more than two errors on the sorting task, did so on the vegetable and fruit items. Sixty per cent of the acceptable sorting errors made by grade 3 children occurred with vegetable and fruit items and all the acceptable grade 6 sorting errors occurred within the vegetable and fruit categories. It is not surprising that these two categories were most easily confused since they are the two categories which are the most interrelated.

Table 8. Results of the Sorting Task for Grades 6 and 3: Number of Subjects Sorting With and Without Experimenter-Provided Labels are Listed Along With the Corresponding Percentages

GRADE 6

	High Verbals		Low Verbals		
	*S*s	%	*S*s	%	Total %
Sorts	60	93.75	57	89.06	91.40
Sorts with Labels	3	4.69	4	6.25	5.47
	63	98.44	61	95.31	96.87

GRADE 3

	High Verbals		Low Verbals		
	*S*s	%	*S*s		Total %
Sorts	50	78.13	46	71.88	75.0
Sorts with Labels	12	18.75	16	25.0	21.88
	62	96.88	62	96.88	96.88

CHAPTER VI

DISCUSSION

This thesis investigated children's understanding of word meaning, with particular interest focused on the encoding of semantic features. Previous research has shown that adults derive complex word meaning from the encoding of multiple features. This study was designed to investigate whether children, like adults, encode several semantic features at a time, thereby exhibiting a similar potential for rich comprehension of word meaning.

Following Bruner et al. (1967), Clark (1973), Anglin (1970) and others, one possible prediction would hold that developmental differences would be found in the encoding patterns of younger and older children. However, the alternative viewpoints of Huttenlocher (1974) and Rosch (1973, 1975) would predict that younger and older children would exhibit comparable encoding patterns if certain relevant variables were controlled in the study.

The two main findings of this study support the work of Rosch and Huttenlocher. (1) Children from grades 3 and 6 gave evidence of multiple encoding of semantic features. (2) For both grades, the recall pattern of the four categories of words on Trial 4 was consistent with the pattern of responses predicted on the basis of adult methods of categorization.

Multiple Encoding

Groups of high and low verbal ability children in grades 3 and 6 recalled the three experimental conditions better than the control condition on Trial 4; that is, all combinations of subject group by experimental condition exhibited significant PI release. However, in order to indicate multiple encoding of semantic features, differences between the three experimental conditions were also required. When Tukey tests were applied to test the differences between the means of the four conditions, the following significant ordering was found: Furniture > Vegetable > Fruit. The meat category was midway between the furniture and vegetable categories and not significantly different from either. Not only did the experimental groups show significant PI release, but also, the amount of PI release differed significantly between two of the three experimental conditions.

It will be recalled from the introductory chapters that Wickens' hypothesis suggests that the greater the shift in meaning on the fourth trial, the greater the PI release (Wickens et al., 1976). Research was cited in Chapter II supporting the theory that shifts in meaning can be obtained through shifts in semantic features,[4] with double shifts (two features changed on the fourth trial) often producing greater PI release than single shifts.

By exhibiting differing amounts of PI release for shifts to different categories, the children of this thesis demonstrated an understanding of the variability in semantic overlap (or the differences in the number of shifted features) between the three experimental and one control category. By perceiving these differences in feature overlap, the children give indications of encoding multiple numbers of features. The results of the experiment are consistent with attribute overlap theory, for the degree of release from PI is inversely related to the degree of feature overlap.

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[4] As indicated in Chapter II, shifts in other types of features also produce PI release: for example, perceptual features, phonemic features and the language of presentation.

Research was discussed in Chapter II which has noted development in children's capacity to scan or process numbers of features. The developmental increase noted in that body of literature was not paralleled in the present study. From the results of this thesis one can conclude that children's capacity to encode multiple semantic features is well-developed by the age of eight years at least for the present set of items. Quite possibly semantic encoding skills develop earlier or independently of the more overt kinds of processing behaviours such as memory span for digits and perceptual scanning of features.

An analysis of the children's responses as they relate to adult methods of categorization will be undertaken before discussing how these results reflect on the theories discussed in the introductory chapters. The two processes of multiple encoding and perception of category membership are interrelated in this thesis and in some of the relevant background literature.

Children's Categorizations

As indicated above, the children made distinctions in the relatedness of the four categories of words and the children's perception of the interrelatedness of these categories was consistent with the formation of concepts according to adult criteria. Not only are their results logically consistent with an analysis of the feature overlap of the four categories, but also, Collen, Wickens and Daniele (1975) have empirical evidence supporting such an assessment of overlap between the categories. In their study, college populations were asked to sort the category names of the Battig and Montague (1969) norms into as many piles as they wished. The percentage of sorts with the fruit category, for the classes of words used in this thesis were: Furniture (0), Meats (70), and Vegetables (95). The children's Trial 4 responses correspond with adult assessments of the overlap in meaning of the four categories of words.

In a study similar to the one undertaken in this thesis, Wickens, Dalezman and Eggemeier (1976) presented adult subjects with a PI release task in which they were shifted from professions, meats or vegetables to fruits. The categories of professions and furniture both received a zero per cent rating, for the number of times they were sorted together with fruit items, on the Collen et al. (1975) task. Wickens et al. (1976) found the following ordering of Trial 4 conditions: Professions > Meats > Vegetables > Fruits. This ordering of conditions is identical to the ordering obtained in this study, if the furniture category is substituted for professions.

Not only did the children in this study distinguish between the four categories of words in a manner consistent with adult sorting patterns, but also the ordering of their responses on Trial 4 was very similar to the ordering exhibited by adult subjects on a similar task. This is not to say that the children and adults had identical feature lists for these categories or that they encoded the same features on the Wickens task. Rather, it indicates great similarity in the feature lists of these four categories for adults and children and also similarity in the methods of processing these features.

This finding is consistent with Vygotsky's (1962) assessment of the formation of children's concepts. He suggests that children's concepts are structured after adult methods of categorization and while children and adults may not comprehend identical meanings for the same concept, they can understand one another because of the considerable overlap in meaning between their two concepts.

The results of this study, which reflect on the questions of multiple encoding and "adult-like" formation of concepts, are consistent with the developmental similarities predictions. Rosch (1973, 1974) has presented evidence that children and adults make similar judgments about categorical meaning, for words which are central members of a category. Consistent with Rosch's findings concerning the selection of core category members on the basis of Battig and Montague ratings, the words presented to the children in this study were central members of their categories. Also, the build-up and release of PI in the Wickens technique are dependent upon the subject categorizing words of the same class, as being similar in meaning, and then distinguishing this first class of words from a second class of words. The results of this study support Rosch's hypothesis (1973) that children and adults make similar judgments about category membership for good examples of the category. The results are also consistent with the body of literature noting that young children organize information according to taxonomic criteria (Rossi & Rossi, 1965; Rossi & Wittrock, 1971; Goldberg et al., 1974; Neimark, 1974).

The predictions of the similarities hypothesis were also derived from the theory of Huttenlocher (1974) who has found children's comprehension of word meaning to be similar to adult comprehension. Although the present study did not investigate differences between comprehension and production, on a Wickens task requiring comprehension of category membership, the children's performance was very consistent with adult performance on a similar memory task (Wickens et al., 1976) and a sorting task (Collen et al., 1975). The children's results offer support for Huttenlocher's theory that children and adults comprehend word meaning in a similar way.

The performance of the grade 6 children was also consistent with the predictions of the differences hypothesis. In agreement with the work of Anglin (1970), Bruner (1967) and Klausmeier et al. (1974) who have found eleven-year-old children to be similar to adults in many aspects of their cognitive processing and language behaviour, the grade 6 children were found to be similar to adults in their methods of semantic encoding.

The grade three children did not perform as suggested by the differences hypothesis. Certainly, there were differences in performance between the grade 3 and grade 6 children and these will be discussed shortly. However, the predicted differences with age in multiple encoding and categorizations did not occur. There were no significant differences between the two grades or the two levels of verbal ability in the ordering of the four conditions on Trial 4. If these results are compared with the results of Wickens et al. (1976) there appears to be great similarity in the patterning of Trial 4 conditions between Wickens' adults and the present group of children.

However, there is one aspect of the grade 3 and grade 6 Trial 4 recall which differs from the performance of Wickens' adult subjects. In three different studies with adults as subjects, Wickens and his associates have found a small amount of PI release when the subjects were shifted from vegetables to fruits. In the present study, the children showed an average difference of 19.02% between the percentage means of the Trial 4 fruit and vegetable data. Wickens et al. (1976), Wickens and Morisano (in Wickens, 1972) and Wickens and Eggemeier (in Wickens, 1973) all found the difference between fruit and vegetable Trial 4 data to be more in the order of 5%.

This difference in the response patterns of adults and children implies that children see fruits and vegetables as being more dissimilar than do adults. The differences hypothesis predicted that young children would not differentiate between fruits and vegetables because the two categories overlap on many features and differ on very few. This is consistent with Clark's (1973) suggestion that features which can be organized hierarchically are acquired from the top down. Features of meaning, such as taste and where grown, which distinguish the fruit and vegetable categories, should, according to Clark, be lower in the hierarchy and therefore acquired later. Fruits and vegetables should be semantically more related, rather than more distant, in meaning.

The children's results do not support this contention. If the response patterns obtained by Wickens and his associates present an accurate picture of adult semantic processing and if the children's results are representative of children's semantic processing, then as the children increase in age, they will learn that the fruit and vegetable categories are more similar in meaning. Perhaps the children will acquire more features common to both categories: the more superordinate the acquired feature, the more it should be a feature common to the two categories and therefore, the more similar the two categories should be in meaning.

A second possible interpretation of the fruit and vegetable difference is that children are more concrete in their thinking and have less ability to abstract the general ties between vegetables and fruits. The sophisticated processing exhibited by the children in the present study does not support this more simplistic interpretation of these results. The children were able to show considerable skill in abstraction by understanding the categorical groupings of the words and by their comprehension of the interrelatedness of these categories. The overall picture is one of complicated semantic processing and if the differences between the Trial 4 responses of the adults and children is a true difference, it probably reflects a difference in attention to certain features rather than a difference in processing skills.

Verbal Ability. The verbal ability factor was included in the study as an exploratory variable. While Hunt et al. (1973, 1975) have investigated this variable with adult subjects and have found significant differences between high and low verbal subjects on many tasks, the probable effect of verbal ability on children's capacity for multiple encoding and their skill in making categorizations was unknown.

The difference in overall recall found between the two verbal ability groups of this thesis is consistent with the research of Hunt et al. (1973, 1975). They found, on a Wickens task employing high and low verbal university students as subjects, that the curves for the two groups were parallel with high verbal subjects recalling more words than low verbal subjects. This same effect was evident in this study

With regard to the question of multiple encoding and "adult-like" formation of categories, the four groups of children in this study, who were organized according to grade and level of verbal ability, all exhibited the pattern of Trial 4 responses described earlier. There were no interactions of verbal ability by grade or verbal ability by condition on Trial 4. Therefore, the conclusions about the effects of verbal ability on multiple encoding and comprehension of category membership are the same as the conclusions for the effects of grade. For this group of children attending regular classrooms, multiple encoding of semantic features and comprehension of category membership were not affected by estimates of the level of verbal ability of the subjects: rather, level of verbal ability simply affected the amount of information recalled.

Memory Capacity

There is a large body of research which has documented an increasing memory capacity as a function of increasing age (Murray & Roberts, 1968; Case, in press). The results of this research support these conclusions. Because of the three year age difference between the two groups of subjects, it was expected that there would be differences in their overall recall.

Case (in press) has analyzed working memory of "m-space" into two subprocesses: these are the strategies or operations employed on the task and storage space. If the operation is complex, requiring much time to execute, then storage space is decreased. Case states that with age, children not only utilize better strategies but also operations become more efficient and automatic, thus leaving more space for storage.

In the present study, if the children's encoding operations can be equated with the transformation operations of Case's research, then possibly the operation of multiple encoding required more "m-space" for the younger children than the older children. This would leave the younger children with less storage space, resulting in poorer recall. The response patterns of both the 8- and 11-year-old groups of children suggested that similar kinds of processing of the semantic information had occurred, with differences between the two groups manifested in terms of differences in overall recall. The results seem to fit Case's model. Although the study was not designed to investigate his hypotheses, it is interesting to note the parallel berween this data and Case's viewpoint.

There were also significant differences in amount recalled for the high and low verbal groups within each grade. As the recall pattern was the same for these subgroups as for the groupings according to grade, the interpretation of the verbal ability data could follow the explanation just offered. Although these subgroupings did not differ by a three year age span, the finding of greater recall in high verbal subjects is consistent with the work of Hunt et al. (1973, 1975) that was discussed earlier.

Summary

Both similarities and differences in children's behaviour as a function of age were apparent in this thesis. This finding is consistent with the general import of the research in the developmental field. Differences are noted in some realms of behaviour and similarities are noted in others. As both effects are simultaneously evident, the hypotheses were not designed to test the validity of one position against the other; the results have offered support for the developmental similarities viewpoint without detracting from the developmental differences research.

PI Build-Up

Conditions. As indicated in Figures 5, 6, 7 and 8, all combinations of conditions and groups demonstrated a build-up of PI over the first three trials. This finding is consistent with previous research using the Wickens technique. The build-up of PI indicates that subjects encoded the items within categories according to some common features, with interitem interference producing a decrement in recall from Trial 1 to Trial 3. The stimulus items were carefully selected to maximize the possibility that children would perceive the category membership. This selection of stimulus items was successful. If the subjects had encoded each word or triad as unrelated items, recall would not have declined steadily across the first three trials and it would not have been possible to measure differing amounts of PI release on Trial 4.

There was some differential build-up of PI for the four categories. A trend analysis was calculated over the first three trials to examine this effect. The linear component of the trend analysis was significant, suggesting that the overall decline between trials 1 and 3 differed for the four conditions. An examination of Figure 2, suggested that the fruit category produced less proactive inhibition than the other three conditions.

This finding, that one class of words is easier to remember than another class, has been documented by several researchers, with both adults and children as subjects. Brown and Atkinson (1974), on a task similar to Wickens', presented adult subjects with words drawn from the categories of occupations and animals. The occupation words were harder to recall than the animal words. On a Wickens task with children as subjects, Hoemann, DeRosa and Andrews (1974) found differential PI build-up and release with items drawn from the categories of kitchen utensils and toys.

Wickens et al. (1976) conducted two experiments in multiple encoding which were similar in method to the procedure of this thesis. Although the results of the two studies were not analyzed conjointly, it appeared from an examination of his figures that the eight different categories of words employed in the two studies exhibited differing amounts of PI build-up.

Three of the four categories studied in this research were examined by Winters and Brzoska (1976). Children found it easier to label and categorize slides of fruit items than vegetable items and vegetable items were in turn easier to label and categorize than furniture items. In a similar study, Nelson (1974) presented children with nine category labels and asked the children to give examples of the categories. Again, children performed better with the fruit category than the vegetable category. However, the children found it easier to list examples for the furniture category and Nelson suggests that this is because "furniture" is a large general category, capable of being subcategorized, while fruits and vegetables are subcategories of the more general category of food.

These studies show that both children and adults experience differences in the ease of recalling different categories of words. Also, the research of Nelson (1974) and Winters and Brzoska (1976) have indicated that children are more knowledgeable about fruits than vegetables. The fruit category appeared to be easiest to recall in the present study. It is not really surprising that there was a tendency for PI build-up to differ for the four categories. It might really be more unusual to expect the four categories to be equally easy to recall, especially for children who are in the process of acquiring well-defined concepts and who are not necessarily acquiring information about categories at a uniform rate.

The differences between conditions which appear on the first three trials refer to children's recall of four different categories of words: fruits, vegetables, meats and items of furniture. Differences in Trial 4 behaviour refer to children's recall of words drawn from a common category, fruits. There were large, systematic and predicted differences in the Trial 4 recall where all children were recalling fruit items. There was a tendency or trend for fruit items to be better recalled on the first three trials, where the subjects were recalling four different classes of material. On the first three trials, all conditions exhibited a significant build-up of PI. On Trial 4, all experimental conditions (subjects recalling fruit items and differing in their experimental histories for the first three trials) showed significant PI release, with a significant ordering of conditions on Trial 4. In spite of the difficulties in equating categories, the differences in the children's age or level of verbal ability, all groups of children showed significant PI build-up and release, with the Trial 4 pattern of responses supporting an hypothesis of multiple encoding of semantic features and "adult-like" formation of categories.

Future Studies

Both high and low verbal ability children in grades 6 and 3 detected the relative amount of feature overlap built into the stimulus materials. There was great consistency in the response pattern for all subjects, even though the low verbal grade 3 group included several children of below average verbal ability. One might speculate that there would be no change in the response pattern if a group of grade 2 high verbal children were studied for purposes of charting the development of word meaning using the Wickens procedure.

One might expect with younger children, for example four-year-olds, to find less differentiation between some of the categories. However, it is quite possible that even these children would show a sensitivity to the degree of feature overlap of the categories. The features comprising a category's meaning might be different; possibly fewer features would be evident. But, where children understood that words differed in meaning, comparable differences in responses on a task such as presented to the children in the present study might also be found. It is suggested that quite possibly young children encode information about words that they have begun to comprehend, in a fashion similar to older children and adults: that is, they encode sets of features, reflecting composite word meanings.

Findings which are analogically similar to the above suggestions were made by Hambley (1969) on a study of short-term memory and aging. Hambley found that what seemed to determine memory loss as a function of age was the subject's ability to enter information into the memory store. Once information was encoded, the process of decay (how the information was stored) was no different for younger and older adult subjects.

As far as the present speculation is concerned, when children begin to enter semantic information into the memory store they may also begin to process information in much the same way as older children and adults. It is suggested that young children differ from older individuals more in the quantity of attributes grouped to form a word's or a category's meaning, than in how they control this information once they have understood it. Certainly this would be a useful question to pursue in future research. Do younger children, like older children and adults, give evidence of multiple encoding of semantic features? The Wickens task can be geared easily to children as the materials can be presented both visually (objects and pictures) and auditorally. By presenting children with categories of words that they understand one can study the children's potential for encoding word meaning.

Another issue one might pursue using the Wickens procedure is children's growing ability to comprehend abstract information. The concrete to abstract developmental continuum could be studied in two ways. First, very common concrete words could be grouped together so that only abstract features interrelated the words. If children were able to show a build up of PI to such a grouping of words they would exhibit encoding of the abstract features. Second, words which were rated as being more abstract in meaning, for example, non picturable words, (Klausmeier et al., 1974) could be grouped into categories and children's encoding of category membership studied. It would be difficult to develop stimulus materials representing categorical groupings of abstract words. As Rosch noted, categorical groupings are often consistent with environmental and biological orderings and these natural groupings are usually of real, picturable objects. But, if one could form a category of abstract words which was salient for adult subjects, one could employ the Wickens procedure to study children's encoding of the abstract features of meaning. In one investigation of the encoding of an abstract feature, Wickens, Clark, Hill and Wittlinger (1968) found that adult subjects did not encode the part of speech to which a word belonged, suggesting that this abstract feature (part of speech) was not used by adults when representing a word's meaning in semantic memory.

The Wickens Technique

The Wickens technique has great potential for describing how children understand word meaning. While some tasks require production of categorizing responses in order to assess semantic organization, the Wickens procedure relies on behaviour which occurs rather covertly as a part of a recall task, in order to measure how information is organized in semantic memory. Huttenlocher (1975) has noted that comprehension often precedes production. By studying comprehension, as in the Wickens procedure, one can gain insight into children's understanding of word meaning without hampering their performance by requiring the use of more poorly developed productive skills.

Huttenlocher (1976) has suggested that the automatic processing of semantic relatedness results from the structural organization of semantic memory. She has noted in her research that the effects of semantic relatedness are equally great whether or not subjects expect the co-occurrence of words related in meaning. She describes a structurally organized memory in which activation of a particular item automatically produces a temporary excitability in semantically neighbouring items. The Wickens procedure taps this phenomenon of semantic relatedness by measuring subjects' potential for comprehension of word meaning, not the subjects' productive abilities, which might lag behind comprehension.

Summary and Conclusions

This study represents an extension of Wickens findings with adult subjects who have given evidence of multiple encoding of semantic features. Children in grades 3 and 6 also exhibited multiple encoding of features of meaning. The children were presented with easy-to-understand, familiar words. When presented with such salient words, they gave evidence of encoding several features of meaning at one time. This research points to the necessity for controlling the difficulty level of the stimulus items. Stimulus items could have been selected that would have been too difficult for children to organize by category. Also, the semantic overlap could have been manipulated so that the differences between categories would have been too abstract for the children to comprehend. No evidence of multiple encoding of semantic features would have been found and children would again have indicated that their understanding and processing of word meaning was less complex than that of adults, thus clouding the investigation of multiple encoding.

The goal of the research was to measure children's competence, a basic-level effect which is sometimes mislabelled as a floor effect. A finding of competence is useful in terms of interpreting results of future studies. If children do not show PI release or multiple encoding on subsequent Wickens tasks, then one can conclude that the semantic features manipulated across categories were not encoded by the children. By analyzing the shifted features one can gain further insight into the semantic processing of children, particularly about the features of meaning salient to children of different ages.

The aim of the stimulus word selection was to provide the children with information which they could understand and to study the organization of information in semantic memory. Both high and low verbal ability children in grades 3 and 6 did encode several features "automatically" and showed a complex organization of information in semantic memory, which was consistent with the organization imposed by adults. The overall similarity in response patterns exhibited by the different groups of subjects suggests a common basis for semantic processing, with differences between different groups of subjects manifested by differences in the total amount of information recalled. Quite possibly, this common basis for semantic processing is inherent in language usage and if this is the case then very young children should show evidence of encoding as many features as possible, rather than evidence of functioning in a unidimensional fashion. This is one question which should be pursued. If younger children do exhibit similar kinds of encoding skills, then the underlying structure of semantic encoding would appear to be common between language users of all ages. The "adult-like" comprehension exhibited by the children may be foreshadowed by structures directing children towards adult understanding. Quite possibly, this cognitive structuring influences semantic encoding from the inception of language learning. Young children may learn to encode along multiple criteria even before they develop speech so that initial language learning already involves multiple encoding of features.

BIBLIOGRAPHY

Anglin, J. The growth of word meaning. Cambridge: M.I.T. Press, 1970.

Anglin, J. M. Word, object, and conceptual development. New York: W. W. Norton & Co. Inc., 1977.

Arlin, M., & Brody, R. Effects of spatial presentation and blocking on organization and verbal recall at three grade levels. Developmental Psychology, 1976, 12, 113-118.

Bach, M. J., & Underwood, B. J. Developmental changes in memory attributes. Journal of Educational Psychology, 1970, 61, 292-296.

Battig, W. F., & Montague, W. E. Category norms for verbal items in 56 categories. Journal of Experimental Psychology Monograph, 1969, 80, 1-46.

Bereiter, C., & Englemann, S. Teacher disadvantaged children in the preschool. Englewood Cliffs: Prentice-Hall, 1966.

Bernstein, B. Social class and linguistic development: A theory of social learning. In A. H. Halsey, J. Floud, & C. A. Anderson (Eds.), Education, economy and society. New York: Free Press, 1961.

Bower, G. H. A multicomponent theory of the memory trace. In K. W. Spence & J. T. Spence (Eds.), The psychology of learning and motivation (Vol. 1). New York: Academic Press, 1967.

Bower, G. H., Clark, M. C., Lesgold, A. M., & Winzenz, D. Hierarchical retrieval schemes in recall of categorized word lists. Journal of Verbal Learning and Verbal Behavior, 1969, 8, 323-343.

Bregman, G. S. Forgetting curves with semantic, phonetic, graphic and contiguity cues. Journal of Experimental Psychology, 1968, 78, 539-546.

Brown, R. W. Words and things. Glencoe: Free Press, 1958.

Brown, W. P., & Atkinson, J. T. O. Categories, subcategories and the attenuation of proactive inhibition in free recall. Memory and Cognition, 1974, 2, 127-129.

Bruner, J. S. The course of cognitive growth. American Psychologist, 1964, 19, 1-15.

Bruner, J. S., Olver, R. R., & Greenfield, P. M. Studies in cognitive growth. New York: John Wiley & Sons Inc., 1967.

Buckingham, B. R., & Dolch, E. W. A combined word list. Boston: Ginn & Co., 1936.

Case, R. Intellectual development from birth to adulthood: A Neo-Piagetian interpretation. In R. Siegler (Ed.), Children's thinking: What develops? Proceedings of the thirteenth annual Carnegie symposium on cognition. Hillsdale: Lawrence Erlbaum, in press.

Checille, R., & Butler, K. Storage and retrieval changes that occur in the development and release of PI. Journal of Verbal Learning and Verbal Behavior, 1975, 14, 430-437.

Clark, E. V. What's in a word? On the child's acquisition of semantics in his first language. In T. E. Moore (Ed.), Cognitive development and the acquisition of language. New York: Academic Press, 1973.

Collen, A., Wickens, D. D., & Daniele, L. The interrelationship of taxonomic categories. Journal of Experimental Psychology: Human Learning and Memory, 1975, 1, 629-633.

Collins, A. M., & Quillian, M. R. Retrieval time from semantic memory. Journal of Verbal Learning and Verbal Behavior, 1969, 8, 240-247.

Collins, A. M., & Quillian, M. R. Experiments on semantic memory and language comprehension. In L. W. Gregg (Ed.), Cognition in learning and memory. Toronto: John Wiley & Sons, Inc., 1972.

Denny, N. W., & Ziobrowski, M. Developmental changes in clustering criteria. Journal of Experimental Child Psychology, 1972, 13, 275-282.

Dillon, R. F. Locus of proactive interference effects in short-term memory. Journal of Experimental Psychology, 1973, 99, 75-81.

Dillon, R. F., & Bittner, L. A. Analysis of retrieval cues and release from proactive inhibition. Journal of Verbal Learning and Verbal Behavior, 1975, 14, 616-622.

Dillon, R. F., & Thomas, H. The role of response confusion in proactive interference. Journal of Verbal Learning and Verbal Behavior, 1975, 14, 603-615.

Felsen, E., & Anisfeld, M. Semantic and phonetic relations in the false recognition of words by third and sixth grade children. Developmental Psychology, 1970, 3, 163-168.

Flavell, J. H. Developmental studies of mediated memory. In H. W. Reese & L. P. Lipsitt (Eds.), Advances in child development and behavior (Vol. 5). New York: Academic Press, 1970.

Freund, J. S., & Johnson, J. W. Changes in memory attribute dominance as a function of age. Journal of Educational Psychology, 1972, 63, 386-389.

Gamlin, P. J. Proverb paper and pencil test: Grades 3 to 13. Toronto: Ontario Institute for Studies in Education, 1976. (Mimeo)

Gardiner, J. M., Craik, F. I. M., & Birtwistle, J. Retrieval cues and release from proactive inhibition. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 778-783.

Ghatala, E. S., & Hurlbut, N. L. Effectiveness of acoustic and conceptual retrieval cues in memory for words at two grade levels. Journal of Educational Psychology, 1973, 64(3), 347-352.

Ginsburg, H. The myth of the deprived child. New Jersey: Prentice-Hall, 1972.

Goggin, J., & Wickens, D. D. Proactive interference and language change in short-term memory. Journal of Verbal Learning and Verbal Behavior, 1971, 10, 453-458.

Goldberg, S., Perlmutter, M., & Myers, N. Recall of related and unrelated lists by 2-year-olds. Journal of Experimental Child Psychology, 1974, 18, 1-8.

Gorfein, D. S., & Jacobson, D. E. Proactive effects in short-term recognition memory. Journal of Experimental Psychology, 1972, 95, 211-214.

Gorfein, D. S., & Jacobson, D. E. Memory search in a Brown-Peterson short-term memory paradigm. Journal of Experimental Psychology, 1973, 99, 82-87.

Hagen, J. W. Some thoughts on how children learn to remember. Human Development, 1971, 14, 262-271.

Hagen, J. W., Jongeward, R. H., & Kail, R. V. Cognitive perspectives on the development of memory. In H. W. Reese (Ed.), Advances in child development and behavior (Vol. 10). New York: Academic Press, 1975.

Hall, J. W., & Halperin, M. S. The development of memory encoding processes in young children. Developmental Psychology, 1972, 6, 181.

Hambley, W. D. Recall and recognition in short-term memory as a function of age. Unpublished Master's thesis, Queen's University, 1969.

Hasher, L., & Clifton, D. A developmental study of attribute encoding in free recall. Journal of Experimental Child Psychology, 1974, 17, 332-346.

Hoemenn, H. W., DeRosa, D. V., & Andrews, C. E. Categorical encoding in short-term memory by 4- to 11-year-old children. Bulletin of the Psychonomic Society, 1974, 3, 63-65.

Hopkins, R. H., Edwards, R. E., & Gavelek, J. R. Presentation modality as an encoding variable in short-term memory. Journal of Experimental Psychology, 1971, 90, 319-325.

Hunt, E. G., Frost, N., & Lunneborg, C. L. Individual differences in cognition: A new approach to intelligence. In G. Bower (Ed.), Advances in learning and motivation (Vol. 7). New York: Academic Press, 1973.

Hunt, E., Lunneborg, C., & Lewis, J. What does it mean to be high verbal? Cognitive Psychology, 1975, 7, 194-227.

Huttenlocher, J. The origins of language comprehension. In R. L. Solso (Ed.), Theories in cognitive psychology. New York: John Wiley & Sons, Inc., 1974.

Huttenlocher, J., & Newcombe, N. Semantic effects on ordered recall. Journal of Verbal Learning and Verbal Behavior, 1976, 15, 387-399.

Kail, R. V., & Levine, L. Encoding processes and sex role preferences (Report 48). Ann Arbor: Developmental Program, Department of Psychology, University of Michigan, 1974.

Kail, R. V., & Schroll, J. T. Evaluative and taxonomic encoding in children's memory. Journal of Experimental Child Psychology, 1974, 18, 426-437.

Keeney, T. J., Cannizzo, S. R., & Flavell, J. H. Spontaneous and induced verbal rehearsal in a recall task. Child Development, 1967, 382, 953-966.

Keppel, G., & Underwood, B. J. Proactive inhibition in short-term retention of single items. Journal of Verbal Learning and Verbal Behavior, 1962, 1, 153-161.

Klausmeier, H. J., Ghatala, E. S., & Frayer, D. A. Conceptual learning and development. New York: Academic Press, 1974.

Kofsky, E. A scalogram study of classificatory development. Child Development, 1966, 37, 191-204.

Lange, G. The development of conceptual and rote recall skills among school age children. Journal of Experimental Child Psychology, 1973, 15, 394-406.

Lange, G., & Hultsch, D. F. The development of free classification and free recall in children. Developmental Psychology, 1970, 3, 408.

Lange, G., & Jackson, P. Personal organization in children's free recall. Child Development, 1974, 45, 1060-1067.

Lappert, R. E. A developmental study of the effect of of conceptual and acoustic similarity on the free recall of verbal materials. Paper presented at the annual meeting of The American Educational Research Association. Chicago: 1974.

Libby, W. R., & Kroes, W. H. Conceptual encoding and concept recall-recovery in children. Child Development, 1971, 42, 2089-2093.

Liberty, C., & Ornstein, P. A. Age differences in organization and recall: The effects of training in categorization. Journal of Experimental Child Psychology, 1973, 15, 169-186.

Loess, H., & Waugh, N. C. Short-term memory and intertrial interval. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 455-460.

Loftus, G. R., & Patterson, K. K. Components of short-term proactive interference. Journal of Verbal Learning and Verbal Behavior, 1975, 14, 105-121.

Mandler, G. Verbal learning. In T. M. Newcomb (Ed.), New directions in psychology (Vol. 3). New York: Holt, Rinehart & Winston, 1967.

McNeil, D. M. The acquisition of language. New York: Harper & Row, 1970.

Moely, B. E., & Jeffrey, W. E. The effect of organization training on children's free recall of category items. Child Development, 1974, 45, 135-143.

Moely, B. E., Olson, F. S., Halwes, T. G., & Flavell, J. H. Production deficiency in young children's clustered recall. Developmental Psychology, 1969, 1, 26-34.

Murray, D. J., & Roberts, B. Visual and auditory presentation, presentation rate, and short-term memory in children. British Journal of Psychology, 1968, 59, 119-125.

Neimark, E. D. Natural language concepts: Additional evidence. Child Development, 1974, 45, 508-511.

Neimark, E. D., Slotnick, N. S., & Ulrich, T. Development of memorization strategies. Developmental Psychology, 1971, 5, 427-432.

Nelson, K. Variations in children's concepts by age and category. Child Development, 1974, 45, 577-584.

Palermo, D. S. Characteristics of word association responses obtained from children in grades 1 through 4. Developmental Psychology, 1971, 5, 118-1233.

Pender, N. J. A developmental study of conceptual, semantic differential and acoustical dimensions as encoding categories in short-term memory (Final Report of Project 9E-070, U.S. Department of Health). Evanston, Ill.: Northwestern University, 1969.

Rinsland, H. D. A basic vocabulary of elementary school children. New York: MacMillan Co., 1945.

Rosch, E. H. On the internal structure of perceptual and semantic categories. In T. E. Moore (Ed.), Cognitive development and the acquisition of language. New York: Academic Press, 1973.

Rosch, E. H. Basic objects in natural categories. Berkeley: University of California, Berkeley, 1974. (Mimeo)

Rosch, E. H. Universals and cultural specifics in human categorization. In R. W. Breslin, G. Bochner & W. J. Lonner (Eds.), Cross-cultural perspectives on learning. Toronto: Wiley & Sons, Inc., 1975.

Rossi, E. L., & Rossi, S. I. Conceptualization, serial order and recall in nursery school children. Child Development, 1965, 36, 771-778.

Rossi, S. I., & Wittrock, M. C. Developmental shifts in verbal recall between mental ages 2 and 5. Child Development, 1971, 42, 333-338.

Russell, D. H. Children's thinking. Boston: Ginn & Co., 1956.

Russell, D. H., & Saadeh, I. Q. Qualitative levels in children's vocabularies. Journal of Educational Psychology, 1962, 53, 170-174.

Schuberth, R. E., Lively, B. L., & Reutener, D. B. Release from proactive interference in the recall of sentences. Journal of Experimental Psychology, 1973, 98(2), 423-425.

Sinclair-de-Zwart, H. Developmental psycholinguistics. In D. Elkind & J. H. Flavell (Eds.), Studies in cognitive development. New York: Oxford University Press, 1969.

Smith, E. E., Shoben, E. J., & Rips, L. J. Structure and process in semantic memory: A featural model for semantic decisions. Psychological Review, 1974, 8(3), 214-241.

Solso, R. L. Memory and the efficacy of cues or "Yes I know!" vs "Why didn't I think of that?" In R. L. Solso (Ed.), Theories in cognitive psychology: The Loyola Symposium. Potomac: John Wiley & Sons, 1974.

Steinberg, E. R., & Anderson, R. C. Hierarchical semantic organization in 6-year-olds. Journal of Experimental Child Psychology, 1975, 19(3), 544-553.

Thorndike, E. L. A teacher's word book of the twenty thousand words. New York: Bureau of Publications, 1931.

Thorndike, E. L., & Lorge, I. The teacher's word book of 30,000 words. New York: Bureau of Publications, 1944.

Tulving, E., & Bower, G. H. The logic of memory representations. In G. H. Bower (Ed.), The psychology of learning and motivation (Vol. 8). New York: Academic Press, 1974.

Tulving, E., & Watkins, M. J. Structure of memory traces. Psychological Review, 1975, 82, 261-275.

Turvey, M. T. Constructive theory, perceptual systems and tacit knowledge. In W. B. Weimer & D. S. Palermo (Eds.), Cognition and the symbolic processes. New York: John Wiley & Sons, 1974.

Underwood, B. J. Attributes of memory. *Psychological Review*, 1969, *76*, 559-573.

Underwood, B. J. Are we overloading memory? In A. W. Melton & E. Martin (Eds.), *Coding processes in human memory*. Washington: V. H. Winston & Sons, 1972.

Vygotsky, L. S. *Thought and language*. Cambridge: M.I.T. Press, 1962.

Wagner, J. F. *A developmental study of categorical organization in short-term memory*. Unpublished doctoral dissertation, University of Connecticult, 1970.

Westman, A. S., & Youssef, Z. I. Kindergarten children's use of category membership. *Journal of Experimental Child Psychology*, 1976, *21*, 507-513.

Wickens, D. D. Encoding categories of words: An empirical approach to meaning. *Psychological Review*, 1970, *77*, 1-15.

Wickens, D. D. Characteristics of word encoding. In A. W. Melton & E. Martin (Eds.), *Coding processes in human memory*. Washington: V. H. Winston & Sons, 1972.

Wickens, D. D. Some characteristics of word encoding. *Memory and Cognition*, 1973, *1*, 485-490.

Wickens, D. D., Born, D. G., & Allen, C. K. Proactive inhibition and item similarity in short-term memory. *Journal of Verbal Learning and Verbal Behavior*, 1963, *2*, 440-445.

Wickens, D. D., Clark, S. E., Hill, F. A., & Wittlinger, R. P. Grammatical class as an encoding category in short-term memory. *Journal of Experimental Psychology*, 1968, *78*, 599-604.

Wickens, D. D., Dalezman, R. E., & Eggemeier, F. T. Multiple encoding of word attributes in memory. *Memory and Cognition*, 1976, *4*(3), 307-310.

Winters, J. J., & Brzoska, M. A. Development of the formation of categories by normal and retarded persons. *Journal of Developmental Psychology*, 1976, *12*, 125-131.

Worden, P. E. The development of the category-recall function under 3 retrieval conditions. *Child Development*, 1974, *45*, 1054-1059.

Appendix A

Description of Vocabulary Tests.

Although the vocabulary tests were not administered as part of the two experiments, they will be described briefly as they formed the basis for dividing the subjects into the two verbal ability levels.

The manual states that the purpose of the Canadian Test of Basic Skills (C. T. B. S.) is to provide information on the progress of students in various areas of academic ability; one of these areas is vocabulary development. The vocabulary subtest is designed to test skills involved in word recognition and knowledge of word meaning, with attention paid to the subject's ability to make fine differentiations in word meaning. The C.T.B.S. manual recommends that performance on the C.T.B.S. be reported in percentiles within a grade and percentile norms are presented for beginning-of-year (October), mid-year (February) and end-of-year (May) testing.

The Gates-MacGinitie Reading Tests are made up of two main subtests; a vocabulary test and a comprehension test. Percentile scores for the vocabulary test were obtained for each grade 3 subject. This subtest is designed to test the child's ability to recognize and analyze the meaning of isolated words.

Appendix B

Frequency lists for meat items established through pilot testing.

Kindergarten

17 subjects assessed: 13 subjects really able to do the task completely.

	frequency of subjects correctly categorizing word as a meat item.
chicken	16
turkey	15
steak	15
bacon	14
ham	14
hamburger	13
hot dog	13
sausage	13
lamb chops	13
spareribs	13
pork chops	13
pork	12
roast beef	12
liver	12
bologna	11
meat balls	11
veal	1 (out of 6 Ss)

Grade 2

7 pupils assessed.

	frequency of subjects listing word as an example of a meat item.
pork	7
ham	7
liver	7
steak	6
salami	5
hamburger	5
pork chops	4
bacon	4
bologna	3
turkey	3
spareribs	3
lamb	2
chicken	2
meat balls	2
deer	2
hot dogs	1
roast beef	1
tongue	1
gizzard	1
fish	7

Grade 3

10 pupils assessed.

	frequency of subjects listing word as an example of a meat item.	
hamburger	10	
ham	9	
chicken	9	
bacon	9	
steak	8	
turkey	8	
liver	7	
deer	7	
pork	6	
hot dog	6	
pork chops	6	
salami	5	
meat balls	4	
roast beef	3	roast 2, beef 2
lamb chops	3	
bologna	3	
lamb	3	
rabbit	3	
spareribs	2	ribs 1
sausage	2	
fish	6	

Grade 5

5 pupils assessed.

frequency of subjects listing word as an example of a meat item.

steak	5		
turkey	5		
roast beef	5		
ham	5		
pork chops	4		
chicken	4		
mince meat	3		
pork	3		
veal	3		
lamb chops	3		
liver	2		
spareribs	2	ribs	1
hamburger	1		
wienerschnitzel	1		
salami	1		
minute steak	1		
bologna	1		

Grade 6

26 pupils assessed.

	frequency of subjects listing word as an example of a meat item.	
turkey	25	
chicken	25	
steak	25	
hamburger	23	
liver	23	
ham	21	
bacon	21	
veal	20	
hot dogs	20	weiners 1
bologna	19	
beef	19	roast beef 11, roast 4
pork	17	
pork chops	16	
lamb chops	16	
sausage	16	
meat loaf	14	
meat balls	12	
salami	12	
mince meat	7	ground meat 1, ground chuck 1, minced steak 1,
ribs	8	spareribs 3, prime ribs 1
tongue	8	cows tongue 2, pigs tongue 1
duck	9	
pig's feet	9	
horse meat	9	

Appendix C

Description of word norms.

Rinsland's (1945) word norms are based on original written productions by children; for example, personal notes, stories, compositions on many school subjects, examination papers. These norms rate the frequency of words according to grade level. However, not all the words to be used in the present study were rated by Rinsland. Buckingham and Dolch (1936) conducted a free association study with over 20,000 children and presented tentative vocabulary lists for grades K to 8. These vocabulary lists were used to assign words to the earliest grade level at which each example was found to be familiar to children. It provided a check on Rinsland's findings as well as a help in determining appropriate grade levels for the words used in the study. Finally, all the words were given ratings according to Thorndike's 20,000 and 30,000 word lists.

When trying to determine an appropriate frequency rating for a word, the ranking according to Rinsland's grade 1 level was used as a first source. Nearly all the vegetable, fruit and furniture items were rated by Rinsland. Some of the meat items were given low frequency ratings or no ratings by the Rinsland study. For these items, reference was made to the additional word norm studies. For example, "steak" was not considered a highly frequent word for first graders by Rinsland but was assigned by Buckingham and Dolch to the kindergarten grade level vocabulary.

Some well-known meat items, such as hot dog and sparerib, which were not listed in any of the normative studies, were frequently mentioned in the data obtained from the school children who participated in the pilot investigations.

Appendix D

Word triads with normative rankings. FRUIT

Battig & Montague Ranking		Freq*	Vocab. level**	# of Syllables
1.	apple	1a3	K	2
2.	orange	1a2	K	2
3.	pear	2a	K	1
4.	banana	2b	K	3
5.	peach	2b	K	1
6.	grape	3a	K	1
7.	cherry	2a	K	2
8.	plum	2b	K	1
9.	grapefruit	2b	K	2
10.	lemon	2b	K	2
12.	apricot	3a	3	3
13.	pineapple	3b	K	3
14.	lime	2b	2	1

TRIADS		X FREQ.	X SYLLABLES	
4.	banana	2000	3	
6.	grape	2500	1	2.0
1.	apple	300	2	
		4800	6	
5.	peach	2000	1	
12.	apricot	2500	3	2.0
2.	orange	200	2	
		4700	6	
3.	pear	1500	1	
10.	lemon	2000	2	1.3
8.	plum	2000	1	
		5500	4	

9.	grapefruit	2000	2	
12.	cherry	1500	2	1.6
14.	lime	2000	1	
		5500	5	

* The information listed in the frequency column should be read from left to right. The first number represents which thousand the word belongs to: the next letter represents which half of the thousand (a = first 5000, b = 2nd 500). If there is another number after the letter, it represents which hundred of the half to which the word belongs.

** Under bocab. level the number represents the grade level for which the word is appropriate, according to Buckingham and Dolch, except for K., which refers to kindergarten. The letter which sometimes precedes the number indicates which study the rating was derived from.

VEGETABLE

Battig & Montague Ranking	Freq.	Vocab level	# of Syllables
1. carrot	2a	K	2
2. pea	3b	K	1
3. corn	1a5	K	1
4. bean	3a	K	1
5. potato	3a	K	3
6. tomato	2b	K	3
7. lettuce	1b2	K	2
8. spinach	2a	K	2
10. broccoli	not rated		3
11. celery	3a	K	3
12. cabbage	1b3	K	2
rice	2b		1
14. cauliflower	3b		4
15. beets	3b	K	1

TRIADS	X FREQ.	X SYLLABLES	
1. carrot	1500	2	
4. bean	2500	1	1.66
7. lettuce	700	2	
	4700	5	
11. celery	2500	3	
3. corn	500	1	1.66
15. beets	3000	1	
	6000	5	
5. potato	2500	3	
- rice	2000	1	2.0
12. cabbage	800	2	
	5300	6	

10.	broccoli	-	3	
2.	peas	3000	1	2.0
8.	spinach	1500	2	
		4500	6	

MEAT

Norms from pilot data		Freq.	Vocab level	# of Syllables
1.	steak	4a	K	1
2.	ham	3b	2	1
2.	chicken	1a4	K	2
2.	turkey	1a4	K	2
5.	hamburger	4a	5	3
6.	bacon	2b	K	2
7.	pork	3b	2	1
8.	beef	3b	K	1
9.	hot dog	-	-	2
10.	roast	3a	K	1
11.	lamb chop	2a	K	2
12.	bologna	-	-	3
	sausage	3b	3	2
	spareribs	-	-	2

TRIADS		X FREQ.	X SYLLABLES	
11.	sausage	3000	2	
1.	steak	3500	1	1.66
2.	chicken	400	2	
		6900	5	
2.	ham	3000	1	
12.	spareribs	-	2	1.66
5.	bacon	2000	2	
		5000	5	
9.	roast	2500	1	
8.	hot dog	-	2	1.33
6.	pork	3000	1	
		5500	4	
12.	bologna	-	3	
8.	beef	3000	1	2.0
2.	turkey	400	2	
		3400	6	

FURNITURE

Battig & Montague Ranking		Freq.	Vocab level	# of Syllables
1.	chair	1a4	K	1
2.	table	1a3	K	2
3.	bed	1a2	K	1
4.	sofa	3b	F4, J3.	2
5.	desk	1a5	K	1
6.	lamp	3b	K	1
7.	couch	3a	K	1
8.	dresser	2a	K	2
9.	television	-	-	4
10.	stool	2b	K	1
12.	rug	2a	K	1
14.	bookcase	-	F2	2
15.	cabinet	2a	-	3

TRIADS		X FREQ.	X SYLLABLES	
5.	desk	500	2	
7.	couch	2500	1	1.66
8.	dresser	1500	2	
		4500	5	
3.	bed	200	1	
4.	sofa	3000	2	1.66
10.	stool	2000	1	
		5200	5	
15.	cabinet	1500	3	
1.	chair	400	1	1.66
6.	lamp	3000	1	
		4900	5	
2.	table	300	2	
14.	bookcase	3500	2	1.66
12.	rug	1500	1	
		5300	5	

Appendix E

NAME________________________ SCHOOL__________________

GRADE______________ TEACHER__________________

CONDITION____________

SUMMARY OF RESULTS

TRIAL 1

TRIAL 2

TRIAL 3

TRIAL 4

PRACTICE LISTS

Trial 1.
1
2
3

Trial 2.
1
2
3

Trial 3.
1
2
3

Trial 4.
1
2
3

Trial 5.
1
2
3

Trial 6.
1
2
3

TEST LISTS

TRIAL 1 SORTING TASK

1.
2.
3.

TRIAL 2

1.
2.
3.

TRIAL 3

1.
2.
3.

TRIAL 4

1.
2.
3.

Blessed Trinity School,
3205 Bayview Avenue,
Willowdale, Ontario.
223-9813

Appendix F

April 27, 1976.

Dear Parent:

Mrs. Janice Hambley, a doctoral student at the University of Toronto, Department of Educational Theory, is conducting research into language development in cooperation with the Metropolitan Separate School Board and would like to include your child in the study. I am writing to request your permission to do so.

The tasks presented to the children are simple ones and require only that the children listen to and remember different combinations of words and numbers. Children enjoy doing the tasks which take only fifteen minutes to complete. The study is concerned with the growth of word meaning during middle childhood (grades 3 and 6) and it is hoped that the information obtained through the study will in the long run enable more effective planning of educational programmes.

The information derived from this study will be treated as confidential and will be used only for statistical purposes. The results will not be entered onto the child's records and will in no way influence his school career. Your cooperation in permitting your child to participate in this research project will be appreciated.

Please complete the permission slip indicating whether you do or do not agree to have your child take part in the project and have your child return it to the school as soon as possible.

Yours truly,

L. Wigglesworth,
Principal.

....

YES I give my permission to include my child in this study.

NO I do not give my permission to include my child in this study.

______________________ (name of child)

______________________ (signature of parent)

Blessed Trinity School

Appendix G

Instructions for practice trials: Letters.

We are interested in how children remember letters and repeat numbers. We will be playing a letter and number game today. You will hear a tone like this ---- and then three letters. Say each letter outloud as soon as you hear it. Then you will hear 14 numbers. Say each number outloud exactly as you hear it. You will have to repeat each number quickly in order to hear the next number. After the numbers, you will hear a tone. When you hear the tone, say outloud the three letters exactly as you remember them. Then get ready for another tone and the next group of letters. Remember, say each letter as soon as you hear it and say each number as soon as you hear it. Are there any questions? If not, are you ready to begin?

Instructions for test trials: Words.

Now we will play a new game. This time we are interested in how children remember words and repeat numbers. We will be doing the same thing as before except, instead of hearing letters, you will hear words. You will hear a tone and then three words. Say each word outloud as soon as you hear it. Then you will hear 14 numbers. Say each number outloud exacly as you hear it. After the numbers, you will hear a tone. When you hear the tone, say outloud the three words exactly as you remember them. Then get ready for another tone and the next group of words. Remember, say each word as soon as you hear it and each number as soon as you hear it. Are there any questions? If not, are you ready to begin?

Instructions for Sorting Task.

Present child with a shuffled set of stimulus cards with the names of the items from the two categories heard during the test trials.

Ask the child to "Read the word on each card" and if he has difficulty doing so, tell him the name. Then say "There are two types of words on the cards and I want you to make two piles so that each pile contains only words of one type." After the sorting is completed ask the child to "Tell me why you sorted the words into those two piles? or "What are the two categories into which you sorted the words?" If the subject fails to sort or sorts incorrectly, tell him the appropriate category names and then ask him to sort the cards on this basis.

Record the child's answers on the last page of the answer booklet.

Appendix H

Basic Summary of Differences when Scoring out of 3.

For the overall interpretation of the analyses of variance, no differences result from scoring out of 3 or 4. That is, the condition effects remain the same, with evidence of multiple encoding of word meaning for both scoring methods. However, some specific differences between high and low verbal ability subjects did occur.

Basically, scoring out of 4 benefitted high verbal subjects more than low verbal subjects and grade 6 children more than grade 3 children. This is perfectly logical since high verbal subjects and grade 6 children tended to show better recall than their counterparts; they were also more likely to recall all three words per triad, offering the possibility of gaining an extra point if the words were recalled in the correct order. An extra point was given only if all three words were recalled correctly and in the right order.

Scoring out of three tended to reduce the steepness of the slope of the line for PI build-up and PI release, since trials 1 and 4 were most affected by the change in scoring. This finding is again logical since total correct recall is higher for trials 1 and 4 when using the Wickens technique, and therefore, the possibility of gaining an extra point for correct serial order is more likely on these trials. These scoring differences did not produce, however, any significant differences in the analyses of variance pertaining to PI build-up or PI release.

For _Trial 1_ both high and low verbal ability subjects in grades 3 and 6 gained from scoring serial position = 1. High verbal subjects gained more than low verbal subjects. For _Trials 2 and 3_, both grade 6 groups gained from serial position = 1, with high verbal subjects gaining more than low verbal subjects. The grade 3 subjects did not gain from scoring out of 4. On _Trial 4_, both grade 6 and 3, high and low verbal ability subjects gained from scoring serial position = 1, high verbal subjects gaining more than low verbal subjects.

Appendix I

Summary Table of Analyses of Variance when scored out of 3 or 4

Repeated Measures by 3 Trials by 2 Grades

Scored from 4		Scored from 3	
grade	p. < .001	grade	p. < .001
VA	p. < .001	VA	p. < .001
Cond.	p. < .01	Cond.	p. < .01
trial	p. < .001	trial	p. < .001
GT	p. < .025	GT	p. < .02
CT	p. < .01	CT	p. < .01

Differences by trial between scoring out of 4 or 3.

T1 = .49 T2 = .17 T3 = .08

Trial = Dependent Variable, 2 grades

Scored from 4		Scored from 3	
Trial 1			
grade	p. < .001	grade	p. < .001
VA	p. < .001	VA	p. < .005
		GV	p. < .05
GV gr 6, High - low =	.24	GV gr 6, High - low =	.04
gr 3, " "	.54	gr 3, " "	.36
	.30		.32
Trial 2			
Grade	p. < .001	grade	p. < .001
VA	p. < .002	VA	p. < .005
Cond	p. < .001	Cond	p. < .01
		B(C)	p. < .02
Trial 3			
Grade	p. < .001	Grade	p. < .001
Cond	p. < .01	Cond.	p. < .02
B(C)	p. < .05		

Trial 4			
Grade	p. < .001	grade	p. < .001
VA	p. < .02		
Cond	p. < .001	cond	p. < .001
Block	p. < .001	Block	p. < .001

Repeated Measures by 4 Trials by 2 Grades

Scored from 4		Scored from 3	
grade	p. < .001	grade	p. < .001
VA	p. < .001	VA	p. < .001
Trial	p. < .001	Trial	p. < .001
GT	p. < .05	GT	p. < .01
CT	p. < .001	CT	p. < .001

Time 4, Grade 6

Cond.	p. < .001		cond.	p. < .001		
Hi VA	2.78	minus	HI VA	2.36	=	.42
Lo Va	2.59		Lo VA	2.27	=	.32
	.19			.09		

Time 4, Grade 3

VA	p. < .02		VA	p. < .02		
Cond	p. < .001		Cond.	p. < .001		
Block	p. < .005		Block	p. < .001		
HI VA	2.26		HI VA	2.00	=	.26
Lo Va	1.81	minus	Lo VA	1.71	=	.10
	.45			.29		

Appendix J

An Analysis of the Types of Errors made on the Memory Task.

GRADE 6 HIGH VERBAL

	Trial											
		1			2			3			4	
Type of Error	S	I	O	S	I	O	S	I	O	S	I	O
# of errors	3		9	3	6	35	6	11	64	7	2	33

GRADE 6 LOW VERBAL

	Trial											
		1			2			3			4	
Type of Error	S	I	O	S	I	O	S	I	O	S	I	O
# of errors	11		6	6	11	44	4	15	74	6	7	34

GRADE 3 HIGH VERBAL

	Trial											
		1			2			3			4	
Type of Error	S	I	O	S	I	O	S	I	O	S	I	O
# of errors	8		25	2	12	70	5	17	91	13	4	47

GRADE 3 LOW VERBAL

	Trial											
		1			2			3			4	
Type of Error	S	I	O	S	I	O	S	I	O	S	I	O
# of errors	15		38	12	28	74	6	26	86	10	18	53

Appendix K

Word Lists

Vegetables List 1.

carrot
bean
lettuce

9 2 7 8 4 2 6 0 4 9 2 1 7 8

celery
corn
beets

3 4 5 1 9 7 2 5 1 6 3 0 1 2

potato
rice
cabbage

6 5 2 5 1 0 7 3 6 8 1 5 4 2

banana
grape
apple

3 1 0 2 7 4 1 2 7 5 8 6 7 2

Vegetables List 2.

broccoli
peas
spinach

7 2 0 8 5 7 8 3 4 7 8 3 7 6

carrot
bean
lettuce

6 1 6 0 1 4 3 8 7 0 6 5 1 3

celery
corn
beets

3 2 1 9 2 7 0 5 6 9 7 6 2 1

peach
apricot
orange

8 3 7 8 7 0 9 8 4 2 6 9 8 7

Vegetables List 3.

potato
rice
cabbage

9 4 7 3 8 1 7 5 7 2 3 5 1 8

broccoli
peas
spinach

5 6 3 5 7 4 9 0 2 4 1 2 6 2

carrot
bean
lettuce

5 9 6 1 9 6 3 0 2 3 0 5 3 6

pear
lemon
plum

2 1 7 9 7 3 5 8 5 9 7 2 9 8

Vegetables List 4.

celery
corn
beets

1 6 4 1 2 7 5 8 6 7 2 0 8 5

potato
rice
cabbage

5 2 6 2 1 4 2 0 9 4 7 5 3 6

broccoli
peas
spinach

9 7 3 5 4 7 5 2 7 9 1 5 4 0

grapefruit
cherry
lime

3 7 1 2 9 4 0 6 2 4 8 7 2 4

Fruit List 1.

banana
grape
apple

4 2 7 6 8 5 7 2 1 4 7 2 0 1

peach
apricot
orange

9 2 4 5 1 8 6 3 7 0 1 5 2 5

pear
lemon
plum

3 2 1 0 3 6 1 5 2 7 9 1 5 4

grapefruit
cherry
lime

4 8 7 1 2 9 4 0 6 2 4 8 7 2

Fruit List 2.

grapefruit
cherry
lime

1 6 7 3 8 7 4 3 8 7 5 8 0 2

banana
grape
apple

0 3 1 5 6 0 7 8 3 4 1 0 6 1

peach
apricot
orange

0 1 2 6 7 9 6 5 0 7 2 9 1 2

pear
lemon
plum

5 7 8 9 6 2 4 8 9 0 7 8 7 3

Fruit List 3.

pear
lemon
plum

5 8 1 5 3 2 7 5 7 1 8 3 7 4

grapefruit
cherry
lime

5 2 6 2 1 4 2 0 9 4 7 5 3 6

banana
grape
apple

8 6 3 5 0 3 2 0 3 6 9 1 6 9

peach
apricot
orange

3 8 9 2 7 9 5 8 5 3 7 9 7 1

Fruit List 4.

peach
apricot
orange

4 9 0 6 5 1 3 2 1 9 2 1 0 2

pear
lemon
plum

1 6 4 1 2 7 5 8 6 7 2 0 8 5

grapefruit
cherry
lime

2 7 8 3 4 7 2 5 1 6 3 0 1 6

banana
grape
apple

7 9 2 5 1 0 7 6 3 8 1 5 4 3

Furniture List 1.

desk
couch
dresser

7 8 7 0 9 8 4 2 6 9 8 9 4 0

bed
sofa
stool

7 3 8 1 7 5 2 3 5 1 5 6 3 9

cabinet
chair
lamp

5 7 4 9 0 2 4 1 2 6 5 9 6 2

banana
grape
apple

1 9 6 3 0 2 3 0 5 3 2 1 7 2

Furniture List 2.

table
bookcase
rug

9 7 4 7 2 6 3 9 1 5 3 2 8 5

desk
couch
dresser

5 9 7 2 7 5 1 8 4 6 0 9 5 2

bed
sofa
stool

8 2 3 2 8 6 1 8 2 9 7 3 5 1

peach
apricot
orange

3 5 4 7 8 3 7 8 1 6 0 1 4 1

Furniture List 3.

cabinet
chair
lamp

3 8 7 0 6 5 1 3 2 1 9 2 7 1

table
bookcase
rug

0 5 6 9 7 6 2 8 3 7 8 7 0 9

desk
couch
dresser

9 8 4 2 6 9 8 9 4 7 3 8 1 7

pear
lemon
plum

2 3 5 1 5 6 3 5 7 4 9 0 2 7

Furniture List 4.

bed
sofa
stool

4 1 2 6 5 9 6 1 9 6 3 0 2 5

cabinet
chair
lamp

3 0 5 3 2 1 7 8 3 7 6 1 6 3

table
bookcase
rug

0 1 4 3 8 7 0 6 5 1 3 2 1 2

grapefruit
cherry
lime

9 2 7 0 5 6 9 7 6 2 8 3 7 2

Meat List 1

sausage
steak
chicken

9 3 4 5 1 8 6 3 7 0 1 5 2 9

ham
spareribs
bacon

5 6 1 0 3 6 1 5 2 7 4 3 8 7

roast
hot dog
pork

7 5 8 0 2 7 6 8 5 7 2 1 4 6

banana
grape
apple

7 2 0 1 2 9 1 2 3 1 5 6 0 9

Meat List 2.

bologna
beef
turkey

7 8 3 4 1 0 6 1 6 7 3 8 9 7

sausage
steak
chicken

8 6 2 4 8 9 0 7 8 7 3 8 2 6

ham
spareribs
bacon

6 7 9 6 5 0 7 9 4 7 5 3 6 7

peach
apricot
orange

5 1 5 3 2 5 7 1 8 3 7 4 9 2

Meat List 3.

roast
hot dog
pork

7 1 2 3 5 0 3 2 0 3 6 9 1 9

bologna
beef
turkey

6 9 5 6 2 1 4 2 1 5 8 2 1 5

sausage
steak
chicken

4 6 7 2 7 3 9 2 7 9 5 8 5 1

pear
lemon
plum

3 7 9 7 4 5 3 7 9 2 8 1 6 4

Meat List 4.

ham
spareribs
bacon

1 0 2 7 4 1 2 7 5 8 6 7 2 0

roast
hot dog
pork

0 8 5 7 8 3 4 7 8 3 7 6 1 0

bologna
beef
turkey

6 0 1 4 3 8 7 0 6 5 1 3 2 4

grapefruit
cherry
lime

1 9 2 7 0 6 9 7 6 2 8 3 6 0

Practice Lists.

1. T
Z
L 2

1 8 4 8 0 1 5 0 1 0 1 5 3 6

2. G
J
S

8 1 6 4 7 9 1 6 4 6 1 4 1 9

3. N
F
P

6 2 5 9 0 3 6 2 0 7 2 0 9 6

4. C
K
M

9 a 2 9 1 4 6 5 7 3 8 5 3 9

5. D
X
H

8 9 1 9 8 2 7 9 8 2 5 3 4 0

6. R
P
N

9 3 9 6 5 3 4 0 9 5 1 9 1 7

7. X
M
C

3 9 6 1 5 2 4 1 3 0 4 8 3 6

8. X
V
M 2

9 7 2 6 5 7 6 3 9 3 6 4 8 0